II. BACKGROUND

This statement provides a detailed description and evaluation of the waste management operations program and its effectiveness at INEL. Included also are descriptions and explanations of the waste management practices followed to ensure control of both radioactive and nonradioactive airborne, liquid, and solid waste effluents at the INEL facilities. In addition, the statement provided a review of the environmental monitoring data that have been collected routinely as part of ERDA's monitoring program for all ERDA facilities.

ERDA has a policy and practice of controlling potential sources of pollution at a level as far below established standards as practicable[1]. The guidelines for implementing these standards are given in ERDA Manual Chapter 0511[1], in the "Plan for the Management of ERDA-Generated Radioactive Wastes"[3], and in the "INEL Waste Management Plan"[4]. Since the late 1960's and early 1970's, the additional emphasis has been placed upon environmental protection. In February 1970, the President issued Executive Order 11507[5] titled "Prevention, Control, and Abatement of Air and Water Pollution at Federal Facilities." This order provided guidelines for Federal leadership in a nationwide effort to protect and enhance the quality of air and water resources. In December 1973, this order was replaced by Executive Order 11752 which provided even stronger Federal leadership in the air and water pollution control effort. Based on this latter order, ERDA issued implementive directives which provide for the control of waste management at ERDA Headquarters and at operational areas[1].

The current basic policies, criteria, and standards for management of ERDA generated radioactive waste at INEL are contained in the ERDA Manual Chapter 0511 (hereafter referred to as ERDAM-0511, September 19, 1973), which provides in part:

(1) Field offices and their contractors shall conduct their operations and dispose of and store radioactive waste in such a manner as to ensure that present and future radiation exposures to individuals and population groups will be at the lowest levels technically and economically practical not exceeding concentration limits established in ERDAM-0524, Appendix Parts I and II;

(2) Continuing efforts shall be made to develop and use improved technology for reducing the radioactivity releases to the lowest technically and economically practical level;

(3) High-level liquid radioactive waste shall not be transported offsite; and

(4) The extent and degree of radioactive contamination of land by ERDA waste management activities shall be minimized.

The basic standards for protection of the health and safety of the public are those contained in ERDA Manual Chapter 0524 (hereafter referred to as ERDAM-0524), which provides in part:

> "ERDA and ERDA contractor operations shall be conducted in such a manner as to ensure that radiation exposures to individuals and population groups are limited to the lowest levels technically and economically practical."

The current criteria and standards for protection of domestic water supplies and control of air pollution in Idaho are found in standards promulgated by the State of Idaho. ERDA-ID uses these standards as guides. In accordance with the provisions of Idaho statutes pertaining to the protection of domestic water supplies (Sections 37-2102, 54-1213, and 39-101, as amended, Idaho Code), standards for chemical, physical, and bacterial purity for water supplies in the State of Idaho were published by the State Department of Health. These standards are found in the following document:

Idaho Drinking Water Standards
Engineering and Sanitation Division
Idaho Department of Health
Boise, Idaho
Adopted 1964.

Where specific water quality standards are not identified in the above document, the Water Quality Criteria and Standards of the State of California are used as guides.

On April 30, 1971, the U.S. Environmental Protection Agency (EPA) adopted certain national primary and secondary ambient air quality standards (Federal Register, Volume 36, No. 87) under authority of Section 109 of the Clean Air Act, as amended (Public Law 91-604; 84 stat. 1676). Under Section 110 of this Federal law, each state was required to adopt and submit to the Administrator of EPA a plan which provided for implementation, maintenance, and enforcement of national ambient air quality standards within each air quality region. Idaho's rules and regulations, which are used by ERDA at INEL, are found in the Rules and Regulations for the Control of Air Pollution in Idaho - Idaho Department of Environmental and Community Services 1972.

A. DESCRIPTION OF INEL OPERATIONS AND FACILITIES

INEL was established in 1949 by the AEC as an area where AEC could build, test, and operate various types of nuclear reactors, support plants, and equipment with maximum safety. ERDA assumed AEC functions in 1975. Originally, INEL was called the National Reactor Testing Station (NRTS). In August 1974, NRTS was redesignated as the Idaho National Engineering Laboratory (INEL) to reflect the broad scope of engineering activities conducted at the station.

As shown in Figure II-1, INEL is situated on the Upper Snake River Plain in southeastern Idaho at an average elevation of 4,900 ft. The station encompasses 571,800 acres. The boundary stretches 39 mi. from north to south and about 36 mi. from east to west at its broader southern part. From Idaho Falls the nearest boundary is 30 air miles toward the west. Blackfoot is 32 mi. southeast of the southern boundary and Pocatello is 50 mi. southeast of the site. Arco lies 7 mi. west of the west station boundary, and with its population of 1,244, is the largest community nearby. Land immediately outside the INEL boundaries is used mainly for range grazing for livestock. However, there is some irrigation farming in areas a few miles north and northeast of the station. Large areas of land are irrigated near the Snake River, about 20 mi. from INEL. No one resides on INEL.

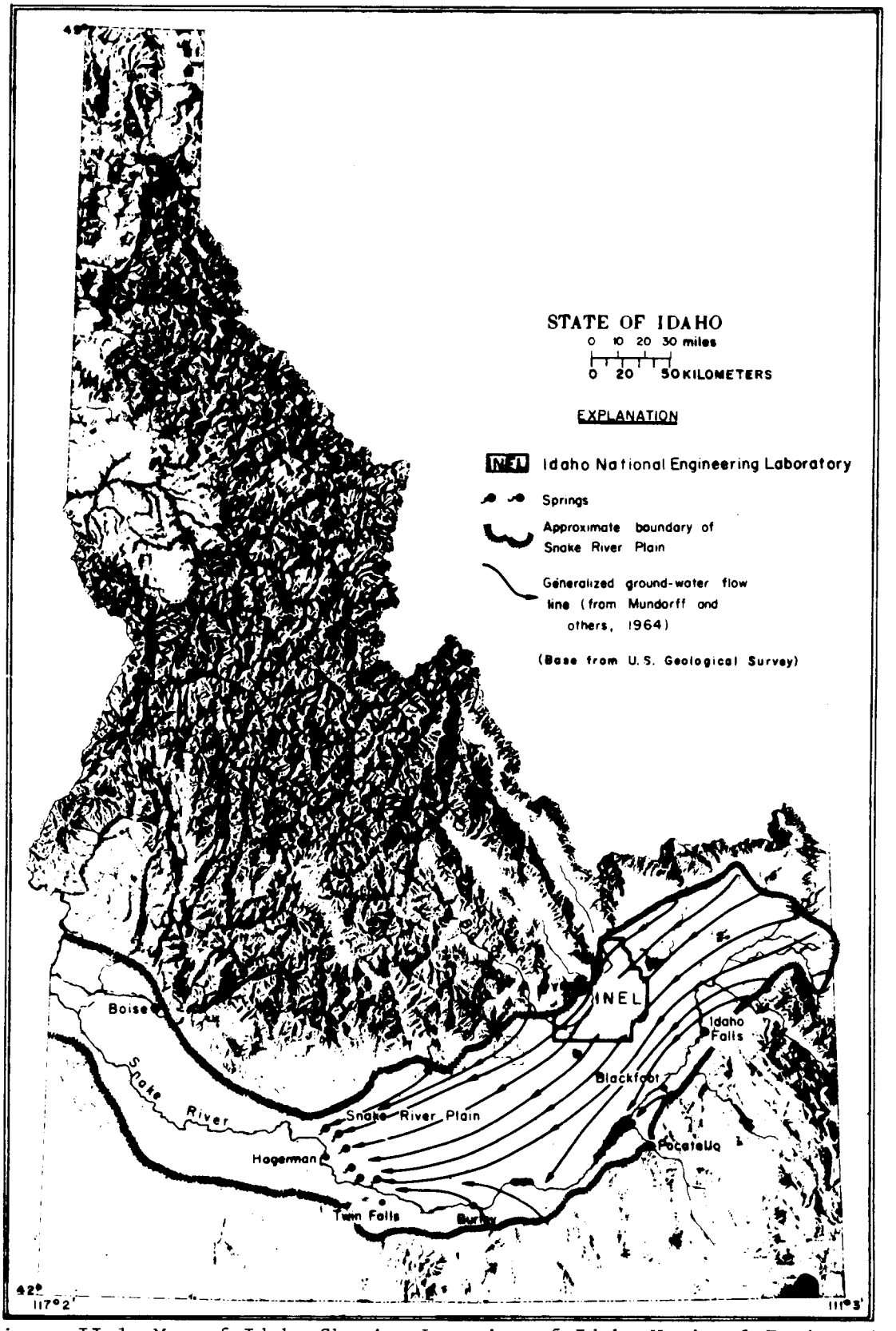


Figure II-1. Map of Idaho Showing Location of Idaho National Engineering Laboratory (INEL), Snake River Plain, and Generalized Ground-Water Flow Lines for the Snake River Plain Aquifer.

The desert plain on which INEL is located is part of the cool desert shrub biome. Vegetation is typical of the cool desert with large sagebrush (Artimesia tridentata) conspicuous over 80% of the site. The animal life often observed on INEL includes the pronghorn antelope, various kinds of birds, reptiles, and small mammals.

The mean annual precipitation is 8.5 in. Underlying the desert plain is a large aquifer system (Figure II-1) in the basaltic lava rock. The lateral flow of this water is about 1 billion gallons/day. The aquifer is recharged from the watershed formed by the mountains surrounding the plain. No surface streams flow from INEL to outlying area, but three streams flow onsite and sink.

Currently four major contractors operate facilities at INEL (see Figure II-2):

(1) EG&G Idaho, Inc. operates the Test Reactor Area (TRA), Test Area North (TAN), Loss-of-Fluid Test (LOFT), Power Burst Facility (PBF), Auxiliary Reactor Area (ARA), INEL Radioactive Waste Management Complex (RWMC), and Central Facilities Area (CFA). The operations at CFA provide support services for outlying INEL operational areas including transportation, warehouses, cafeteria, laundry, purchasing, and other services.

(2) Allied Chemical Corporation (ACC) operates the Idaho Chemical Processing Plant (ICPP).

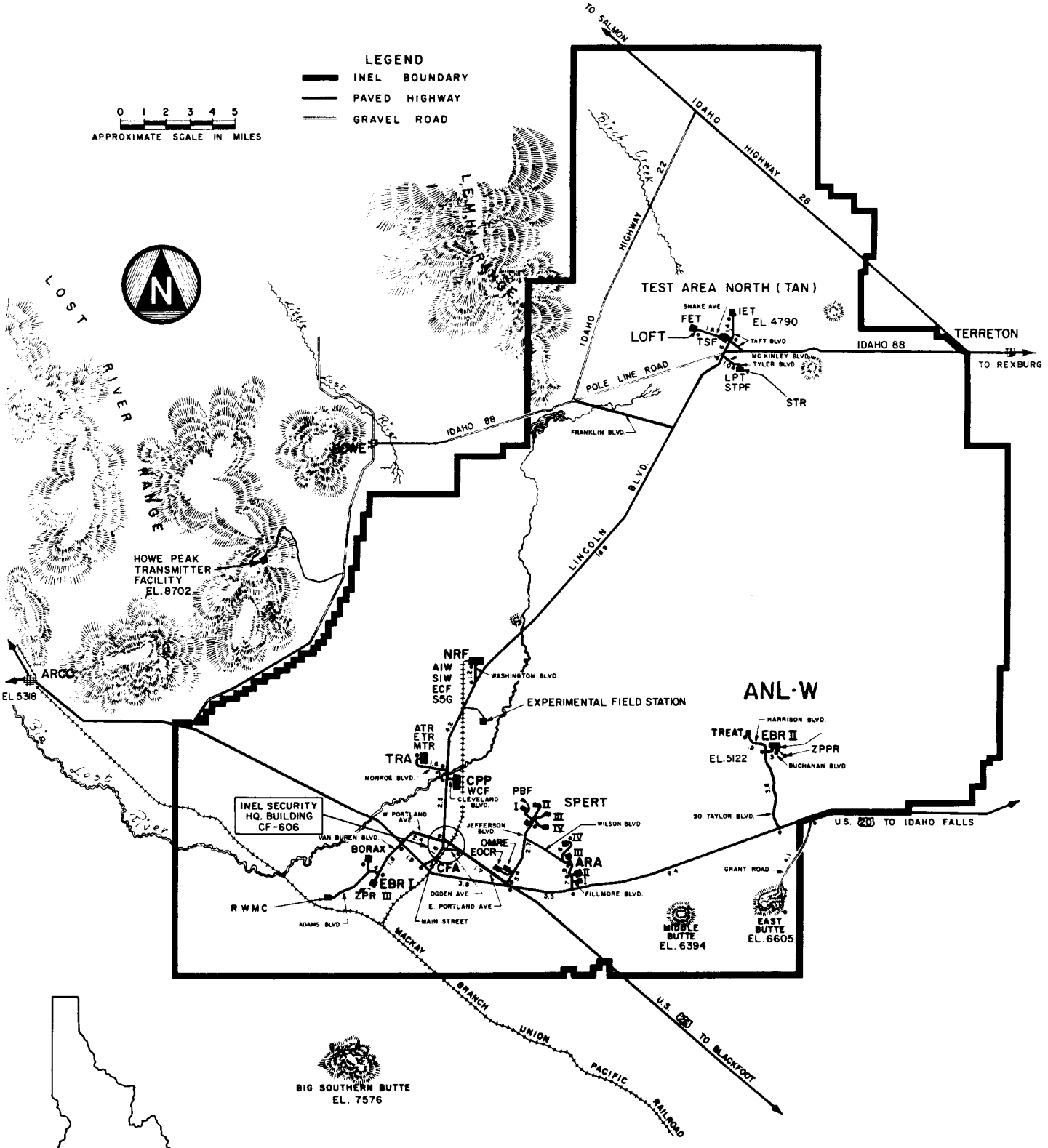
(3) Argonne National Laboratory (ANL) operates Argonne National Laboratory West (ANL-W) which includes the Experimental Breeder Reactor No. 2 (EBR-II) and other associated facilities.

(4) Westinghouse Electric Corporation (WEC) operates the Naval Reactor Facility (NRF).

These facilities support five major programs at INEL. One program provides test irradiation services from the two operating high-flux test reactors: the Engineering Test Reactor (ETR) and the Advanced Test Reactor (ATR) at TRA. A second major program is that of light water-cooled reactor safety testing and research. LOFT and PBF reactors are the major projects in the reactor safety program. ICPP recovers uranium from a variety of spent reactor fuels and conducts and demonstrates technology for the treatment of high-level radioactive liquid waste. An important and expanding segment of INEL responsibilities consists of assignments for furthering ERDA's Liquid-Metal Fast-Breeder Reactor (LMFBR) program. This research is being conducted principally at the ANL-W area. NRF is a training and experimental facility for U. S. Navy nuclear programs.

All of these INEL operations produce various quantities of radioactive and nonradioactive waste effluents. The processes by which the radioactive wastes are produced and controlled at all of the INEL

IDAHO NATIONAL ENGINEERING LABORATORY



(See Appendix B for a list of abbreviations.)

Figure II-2. INEL Facility Locations.

reactors are similar (ICPP processes differ in that it is a fuel reprocessing facility). The major radioactive contaminants from reactor operations are fission and activation products. The fission process within the reactor produces the fission products. The reactor fuel and the fission products formed during nuclear operations are contained within sealed metal sheaths called "fuel elements." Although strenuous precautions are taken to contain all of the fission products within the fuel elements, 100% containment is not possible. For example, some fission products migrate through the fuel element cladding and become entrained in the primary coolant fluid. Further, the radioactive activation products that result from activation of reactor internals and primary coolant impurities also are present in the primary coolant stream. These gases are removed from the liquid in degassing vessels and are routed to waste gas systems prior to release from high-rise stacks. Most INEL reactors use closed-cycle and water-cooled systems. The closed-cycle systems (called the "primary coolant systems") contain most of the radioactivity and are not discharged to waste systems until the reactor is shut down and the primary system is drained. Additional effluent from sample and purge streams, both of which contain small quantities of radioactivity, are discharged continuously to waste systems during reactor operation. In addition to short-lived isotopes which decay rapidly, minor quantities of long-lived fission and activation products (e.g., tritium, chromium-51, strontium-90, and cobalt-60) are in the waste stream. Expended fuel elements, which contain most of the fission products and unfissioned uranium, are removed from the reactor and transferred to ICPP in shielded containers for recovery of the uranium. At ICPP the fuel elements are subjected to chemical procedures. First, they are dissolved by acids. The uranium in the acid solution then is chemically separated from the other materials. The high-level radioactive waste, containing the fission products and transuranics, then is routed temporarily to underground storage tanks. Subsequently, it is solidified and stored as a calcined solid.

Each of the INEL facilities also routinely generates nonradioactive industrial and sanitary wastes. These wastes are primarily chemically contaminated water and fossil fuel combustion byproducts. The liquid chemical wastes are either routed to seepage ponds or are discharged to disposal wells. Sanitary wastes are treated and then discharged to ponds or shallow subsurface irrigation fields. Fossil fuel combustion by-products are released to the atmosphere.

To ensure compliance with the above mentioned standards, all effluent waste streams are controlled, processed, and sampled prior to release. This procedure has been in effect since the establishment of INEL. The waste disposal data were collected and processed manually until 1971; at that time, a computerized system was developed which has been designated as the Waste Management Information System (WMIS)[8]. The purpose of this system is to provide timely and accurate computer generated reports indicating the amount of airborne, liquid, and solid radioactive and industrial waste that has been disposed of and stored at INEL. WMIS, in addition to providing a timely and accurate reporting system, has yielded a broad data base which has proven useful at various levels of management in appraising radioactive and industrial waste programs. The radiological and industrial waste data presented in this document were obtained from WMIS. While precise and traceable, these data, however, could be misunderstood if not properly utilized. In those cases where a long-lived parent decays to a short-lived daughter (i.e., cerium-144 to praseodymium-144, strontium-90 to yttrium-90), only the radioactivity of the parent nuclide is presented in this environmental statement. In these situations secular equilibrium has been established and the activity of the parent nuclide and daughter nuclide will be practically the same. The daughter nuclide will be present in identical curie amounts but is not presented in any of the tables in this document. Further, except where specified, all radioactive waste amounts are stated as of the time they become classified as wastes, with no allowance being made for radioactive decay.

Summary descriptions of each of the INEL facilities and their respective waste management programs are given in the following subsections.

1. Argonne National Laboratory - West (ANL-W)

The ANL-W facility[9] area is situated on the extreme southeastern portion of INEL as shown in Figure II-2. It currently consists of five major complexes: the Experimental Breeder Reactor No. 2 (EBR-II), the Transient Reactor Test Facility (TREAT), the Zero Power Plutonium Reactor (ZPPR), the Hot Fuel Examination Facility (HFEF), and the Laboratory and Office (L&O) and the support complex, all of which are operated by ANL for ERDA. Figure II-3 is an aerial view of the ANL-W area,

EBR-II

EBR-II is an experimental liquid-metal cooled fast-breeder reactor which became operable in 1961. EBR-II is an unmoderated heterogeneous, sodium-cooled reactor with a thermal power output of 62.5 MW, an intermediate closed-loop secondary heat transfer system, and a steam/electric plant that is designed to produce 20 MW of electrical power through a conventional steam turbine generator. The reactor plant, originally designed to demonstrate its engineering concept, is the prime ERDA facility for irradiating samples of reactor fuels and structural materials for the Liquid-Metal Fast-Breeder Reactor (LMFBR) development program[10,11].

The entire reactor is submerged in a large container (primary tank) filled with ~90,000 gallons of molten sodium. The molten sodium is pumped through the core of the reactor, then through a heat exchanger to transfer the heat from the primary sodium system to a secondary system, also containing sodium. The primary sodium, which is radioactive, is confined to the primary tank and is isolated from the nonradioactive secondary sodium.

The primary system is located exclusively within the confines of the reactor building, a cylindrical gastight steel containment shell. The primary system includes the reactor system, which generates heat by nuclear fission; the primary cooling system, which absorbs heat from the reactor and transfers the heat in the intermediate heat exchanger to the secondary system; and a fuel handling system, for removal and insertion of subassemblies in the reactor.

Also associated with EBR-II, but outside the containment building, are a cooling tower to dissipate the 42.5 MW of thermal energy rejected by the condenser, a component cleanup facility, and a fuel assembly and storage building. The component cleanup facility is a 25- x 35-ft concrete slab covered with carbon steel, a 2,500-gallon carbon steel retention tank, and the necessary equipment and hardware for retention and disposal of liquids. Components containing sodium are cleaned by reaction with water and/or alcohol.

TREAT

TREAT is a reactor designed to produce short extreme pulses of nuclear energy with resultant temperatures high enough to permit meltdown studies of selected prototype and experimental fuel elements.

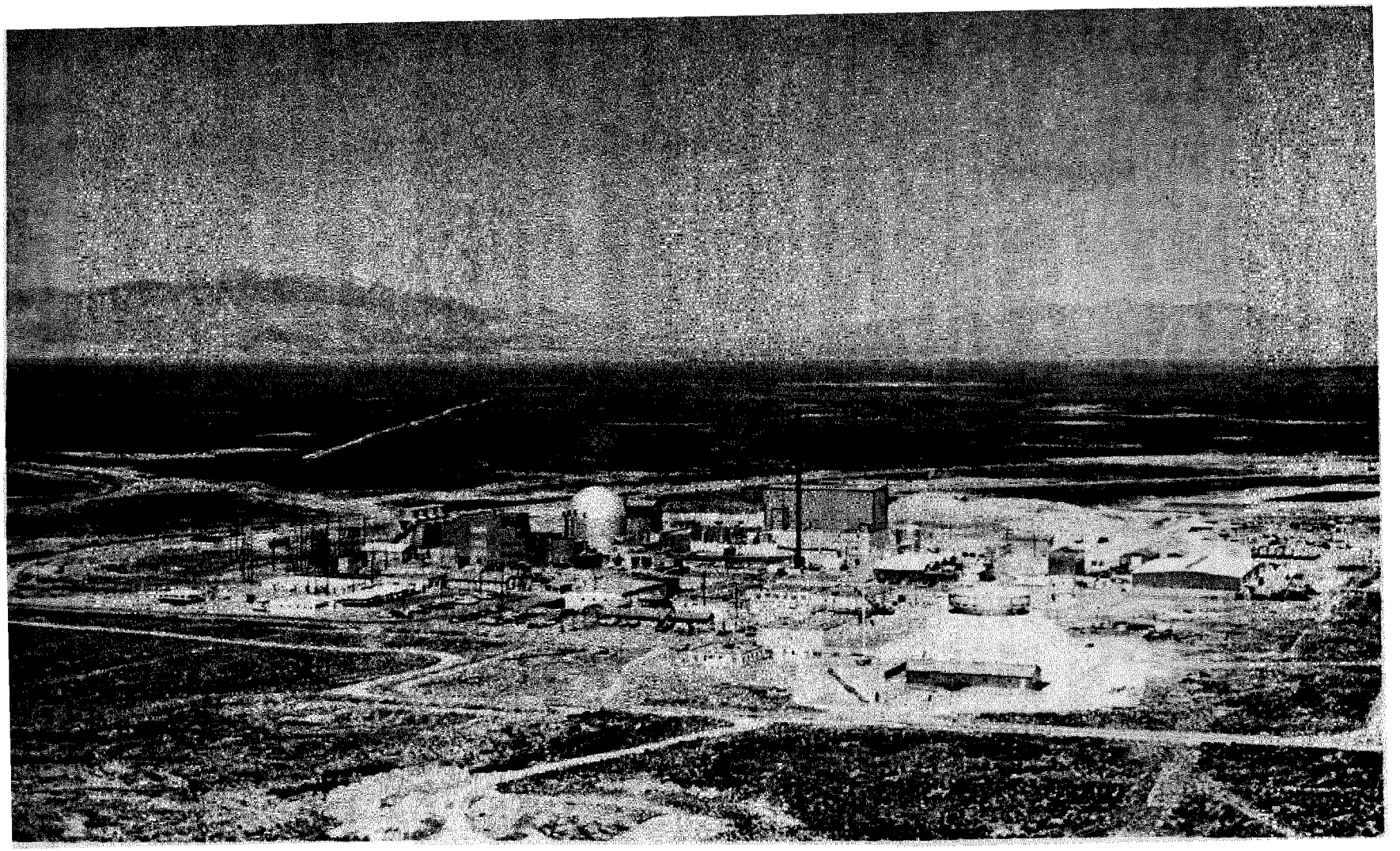


Figure II-3. Aerial View of ANL-W.

The reactor became operational in February 1959. The immediate objective of TREAT tests is to provide quantitative data and indirect visual information on the mechanism of melting fast reactor fuel elements by nuclear heating analagous to a power excursion in a fast reactor core[12,13].

A unique design feature is its shielded viewing slots on two of the reactor faces. Both optical and gamma camera techniques have been developed for use with these two slots so that reactive mechanisms taking place in samples can be recorded on film for detailed study. The TREAT complex comprises a reactor building and a control building located northwest of the EBR-II reactor building.

ZPPR

ZPPR is situated about 1,000 ft southeast of the EBR-II reactor. Experiments using ZPPR provide reactor physics information needed for designing and developing large plutonium fueled fast-breeder reactors for future commercial nuclear powerplants which will generate up to 1,000 MW of thermal power[14,15].

ZPPR consists of two assemblies of honeycombed lattices mounted on separate steel tables. The tables are kept separated while the lattices are loaded with drawers of mockup fuels and other materials, and then are brought together for operation. Because the materials can be loaded in a variety of patterns, ZPPR can be used to simulate many reactor core designs.

The ZPPR cell is housed in a 50-ft-diameter concrete building approximately 32 ft high. The building has concrete access tunnels to the vault building and the outside. The entire cell, the tunnels, and the vault building are enclosed in an earth mound approximately 50 ft high. The roof of the cell ($\sim$2,000 ft^2) is filled with a sand-gravel mix to a minimum depth of 16 ft. The cell roof would serve effectively as an air filter in case of a major accident.

HFEF

HFEF consists of two separate buildings: HFEF-South serves primarily as an irradiated subassembly-disassembly inspection assembly point, and HFEF-North serves primarily diagnostic and inspection functions[16,17,18].

HFEF-South is comprised of an argon atmosphere cell and an adjacent air atmosphere cell. Irradiated reactor subassemblies are disassembled, inspected, and reassembled in these cells. The argon cell provides a radiation shielded area where fuel can be exposed in an inert atmosphere during processing operations. The facility is devoted entirely to examination of materials and fuels irradiated in EBR-II and TREAT for the LMFBR program. An operating area used by personnel surrounds the two cells. The HFEF-South facility is designed to handle core subassemblies with activities up to about 500,000 Ci. The cells are shielded for gamma radiation levels of up to 10^6 R/hr. The HFEF-South building has access to the EBR-II reactor building for transferring fueled subassemblies in a suitable shielded cask between the reactor building and the fuel

examination facility. Here reactor subassemblies can be disassembled and reassembled, and fuel elements can be inspected and tested by remote nondestructive methods[19].

The HFEF-North building is used for interim and final examination of fast reactor fuel and structural specimens irradiated in facilities supporting the LMFBR program. The main cell is constructed of high-density concrete with a gastight steel lined enclosure. An argon atmosphere in the cell provides an inert atmosphere needed for remote examinations.

Laboratory and Office (L&O) and Support Complex

The remainder of ANL-W is designated as the L&O and the support complex. These consist of the laboratory and office building, a firehouse, waste treatment buildings and facilities, storage facilities, pumphouses, substations, and other miscellaneous buildings.

a. Systems for Venting Radioactive Airborne Wastes[a]

EBR-II

Radioactive airborne effluent from the EBR-II complex (Figure II-4) consists of noble gas fission products (which include isotopes of xenon and krypton and their daughter products) and of products due to activation of the argon cover gas (which include argon-41, short-lived isotopes of oxygen and nitrogen, and tritium). The argon cover gas in the primary tank is located in a plenum immediately above the surface of the primary sodium[20,21]. Because of a positive pressure differential (i.e., pressure inside the tank is greater than that outside it), any leakage from the cover gas enters the containment building. The building atmosphere containing this gas is withdrawn through the shield cooling system, through high efficiency particulate air (HEPA) filters, and recombined with building atmosphere containing the remaining gas which is withdrawn through a thimble cooling system (a monitoring device for the reactor flux) and also passed through the HEPA filters. The combined flow then passes through a radiation monitor, through a blower, to a 200-ft-high exhaust gas stack. Downstream of the HEPA filters, there is a constant air monitor to determine the particulate concentration of the airborne discharge from the containment building. If the monitor alarms, the reactor is shutdown and the condition is investigated and corrected. The containment building may be isolated from the stack discharge either manually or automatically, to prevent emission of radioactive gases to the atmosphere. Automatic isolation is initiated by a gamma monitoring system. Manual isolation is initiated in the control room by the shift supervisor.

During operations in which various fuels are tested, fuel cladding failures may occur. In this event fission product noble gas concentrations increase. In order to identify the subassembly containing the failed element, continued reactor operation may be necessary; however, this

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[a] See Appendix E, Section 3.A. for system improvements completed during 1975-76.

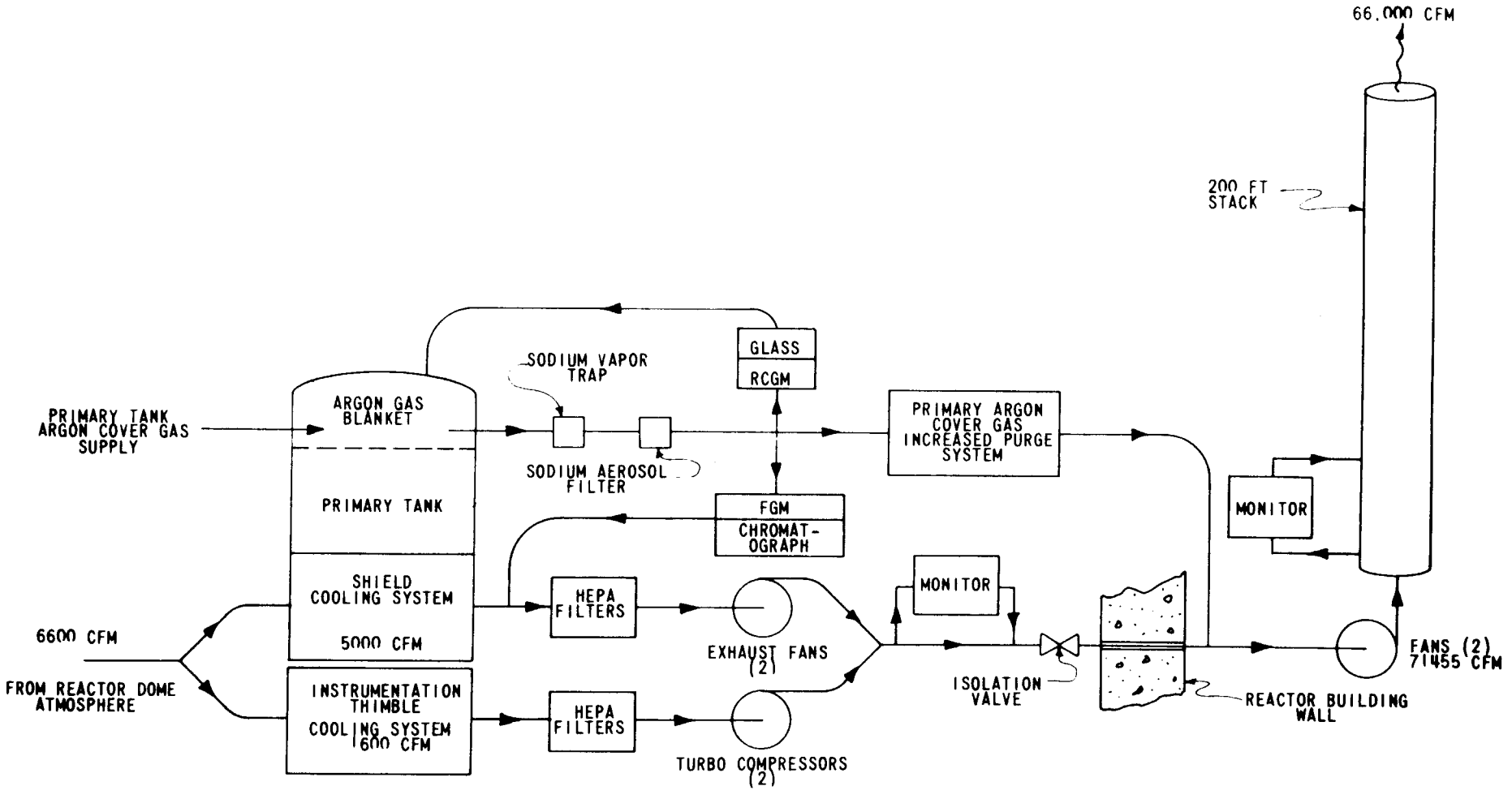

Figure II-4. EBR-II Radioactive Airborne Waste System -- Reactor Plant.

may increase the fission product concentrations in the argon cover gas and in the containment building. It then would become necessary to purge the cover gas system to reduce the fission product concentration. The purge discharge rate is determined by measuring the concentrations of nuclides in the containment building so that discharge limits are not exceeded. The purged argon cover gas is exhausted at a rate of up to 3 ft^3/min through a vapor trap and a 10 μ sintered metal aerosol filter into the stack system. The purge does not pass through HEPA filters. The system is shown in Figure II-4 as the primary argon cover gas increased purge system.

The concentrations of radionuclides in the containment building increase as cover gas activity and gas leakage increase. When such increases are detected, gas samples from the containment building are analyzed to identify the contaminants and their concentrations. If the activity levels are within predetermined acceptable limits, the atmosphere in the containment building area may be purged directly to the outside atmosphere through a 6,000-ft^3/min centrifugal blower in addition to that processed through the HEPA filter system previously described.

The systems used to monitor the cover gas are as follows[22,23,24]:

(1) Fission gas monitor (FGM) - The FGM consists essentially of four major components: a cover gas delivery system, an electrostatic precipitation chamber, a water-mercury trap, and a radiation detection system. Two independent gamma sensitive radiation detectors are used to monitor the activity level of alkali-metal daughters of the radioactive rare gases. Signals from the monitoring equipment are transmitted to the control room, where they are displayed in count rate form on appropriate strip chart recorders.

(2) Reactor cover gas monitor (RCGM) - The RCGM consists essentially of the three separate single-channel pulse height analyzers for on-line (continuous) analysis of xenon-133, xenon-135, and krypton-85m. The outputs of the three analyzers are displayed in count rate form on appropriate strip chart recorders in the reactor control room.

(3) Germanium lithium argon scanning system (GLASS) - The GLASS consists of a lithium drifted germanium detector and a pulse height analyzer. Because of the much higher resolution afforded by this detector, minute amounts of rare gas fission products, other than xenon-133 and xenon-135, may be observed. Cover gas samples are collected and routinely analyzed in laboratories for xenon-133, xenon-135, and also for argon-41.

In 1974 the concentration of radioactive airborne waste discharged from the EBR-II plant in 3.4 x 10^9 ft^3 of air was 0.06 Ci of argon-41, 0.005 Ci of krypton-85, 367 Ci of xenon-133, 147 Ci of xenon-135, 0.07 Ci of bromine-82, and 0.7 Ci of tritium.

As previously stated, the component cleanup facility is part of the EBR-II complex. The facility is utilized to clean sodium contaminated equipment and components. These are removed from the reactor building and held at a staging area to permit radioactive decay of the short-lived nuclides such as sodium-24 (15 hour half-life) and to permit oxidation of residual sodium. The gaseous effluents from the reaction of sodium and water alcohol during the cleanup operation are discharged directly to the atmosphere. No measurements of the total release from the pad area have been attempted. Calculations using worst-case parameters indicate that the major constituents released would be 243 μCi of cesium-137, 770 μCi of sodium-24, and 880 μCi of tritium during each reaction event. Reactions on the pad average two per month. Air samples taken during this reaction have not detected any activity above background.

All airborne effluent from the fuel assembly and storage building, excluding sanitary vents, is treated as radioactive. All air is exhausted through three parallel banks of HEPA filters consisting of six filters per bank. The particulate content of the airflow downstream of the HEPA filter system is sampled continuously using a forced flow, fixed filter sampling device. The filter element is replaced and analyzed for radioactivity each month.

During 1974, radioactive airborne waste streams contained no beta-gamma or alpha particulate radioactivity above the detectable concentration of 1×10^{-14} μCi/cm^3.

TREAT

During reactor operation, airborne gaseous effluent is treated as radioactive. As a design safeguards feature, all gaseous effluent from the reactor is exhausted through a bank of six parallel HEPA filters by means of two parallel turbocompressors. The airborne effluent discharges into a 60-ft-high exhaust stack. Airflow downstream of the HEPA filter system is monitored continuously for radiation level before the air is discharged out the exhaust stack. In addition, periodic cold trap sampling is performed to determine radionuclide constituents and concen-trations. An interlock is provided on two of the three roof vent fans to prevent discharging of gases through the roof vent system (used when the reactor is not operating) during reactor operating periods.

The radioactive waste stream is comprised of the noble gas radioisotopes of argon, krypton, and xenon. During 1974, the following quantities of radionuclides were discharged to the atmosphere from the TREAT facility:

Radionuclide	Curies
argon-41	148.2
krypton-85	0.14
krypton-87	0.63
krypton-88	0.37

Radionuclide	Curies
xenon-133	0.16
xenon-135	0.07

ZPPR

The heating, ventilating, air conditioning, and exhaust systems are designed so that airflow is from clean areas inward toward potentially radioactively contaminated areas. This kind of system prevents the spread of radioactivity. All air collected from the potentially radioactive areas is channeled through hoods into an exhaust system, which discharges the air through three banks of HEPA filters, then out a stack. No air is discharged from the reactor room during reactor operation.

During reactor operation, reactor cooling air is recirculated (not exhausted to atmosphere) through HEPA filters. The filtered air is monitored continuously by a plutonium (alpha) air monitor. In addition, the reactor cooling air is monitored for beta-gamma-emitting particulates by a forced flow, fixed filter continuous air monitor. When the reactor is not in operation, the cooling air is channeled through HEPA filters and is monitored upstream and downstream from the filters before being discharged out a 60-ft-high exhaust stack. The upstream monitor detects alpha- and beta-gamma-emitting particulate matter and alarms at an alpha concentration of 2×10^{-8} $\mu Ci/cm^3$ and at a beta-gamma concentration of 2×10^{-7} $\mu Ci/cm^3$. The downstream monitor also detects alpha and beta radioactivity; the alpha monitor alarms at concentrations of 6×10^{-12} $\mu Ci/cm^3$ or greater, and the beta monitor alarms at concentrations of 1×10^{-10} $\mu Ci/cm^3$ or greater.

An ion chamber for gamma ray detection is inserted in the exhaust gas stream in the 60-ft-high exhaust stack and is read out remotely on the reactor control room panel. The chamber is set to alarm at a 10-mR/hr radiation level. Reaching the setpoint radiation level shuts down the reactor and isolates the area.

The radioactive airborne waste stream contains small quantities of noble gas fission products. During 1974, 0.17 Ci of xenon-135 was discharged in 2.1×10^9 ft^3 of air. No radioactive particulates above the minimum detectable concentration of 5×10^{-14} $\mu Ci/cm^3$ were discharged.

HFEF-S

Ventilating air leakage paths within the building cause the internal air to flow from clean areas toward areas having a slight possibility of being contaminated, then to areas with still a greater possibility of contamination. Furthermore, the internal building pressure is maintained at less than atmospheric pressure to prevent outleakage. In Figure II-5 is shown the ventilation air flow for the HFEF-S. After flowing through the building, the air is cleaned by passing through 36 HEPA filters installed in parallel in order to handle the building exhaust. The filtered air then moves through an underground welded-steel pipe and out the 200-ft-high exhaust stack.

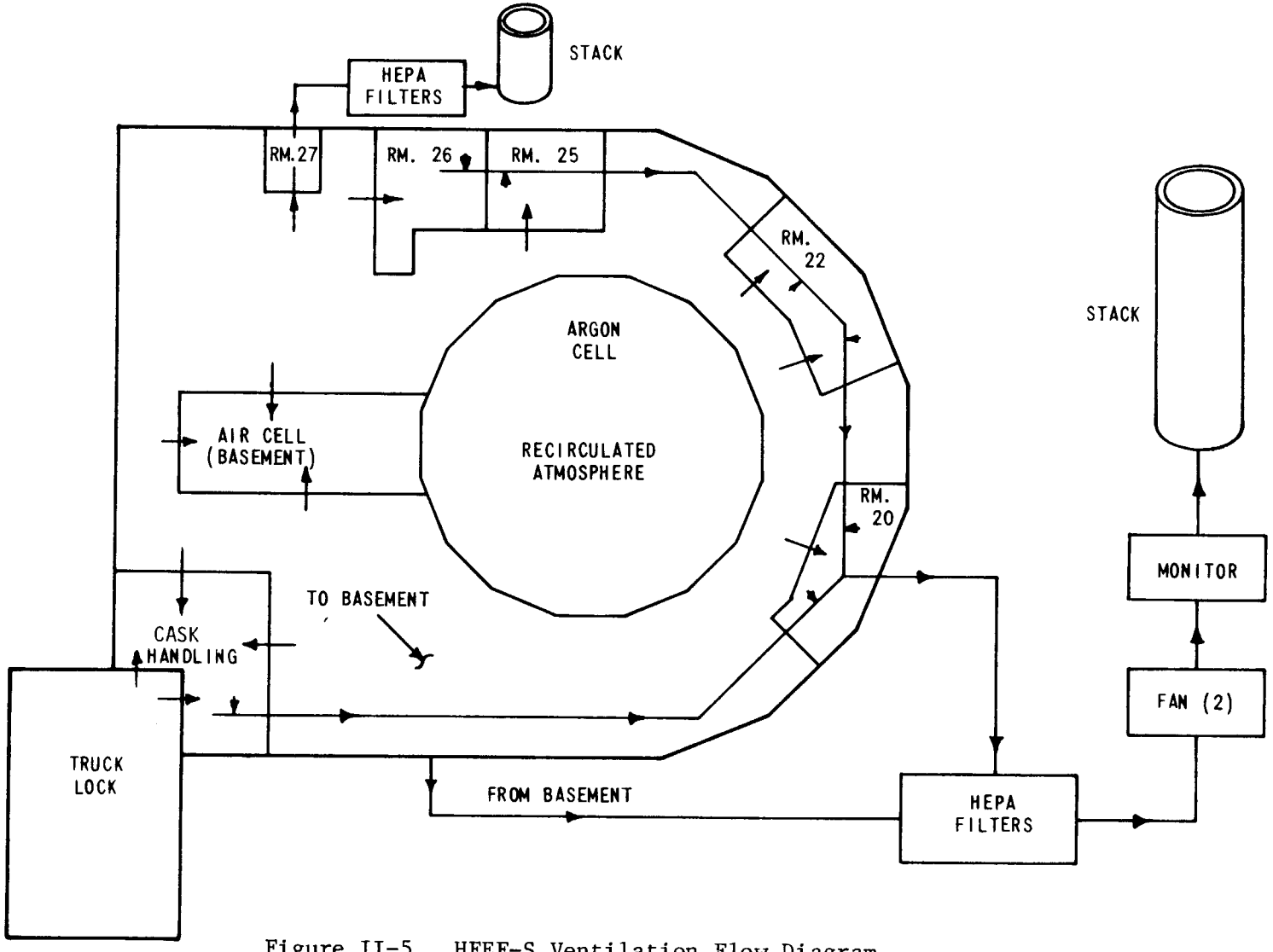

Figure II-5. HFEF-S Ventilation Flow Diagram.

There are two work areas with air exhaust and filtering systems separate from the aforementioned facility system. These areas are cleanup facilities that have been modified and designed for special applications. One area contains a plutonium glove box; the area is equipped with a specially designed filtering system which is activated by glove box pressure level. Should glove box pressure exceed design limitations, the glove box air and the room air bypass the normal ventilation path and are exhausted directly to the atmosphere through three HEPA filters set in series. The other area utilizes its own wall mounted blower system, which exhausts through HEPA filters and then to its own stack.

During 1974, 1.2 Ci of xenon-133 from the HFEF-S were discharged in 1.6×10^{10} ft^3 of air. No particulate radioactivity greater than the minimum detectable was discharged. The minimum detectable for beta is 1×10^{-9} $\mu Ci/cm^3$. Although alpha particulate is not presently monitored, the beta to alpha ratio in HFEF-S is about 1,000 to 1. The conclusion is, therefore, that no alpha particulate concentrations greater than 1×10^{-12} $\mu Ci/cm^3$ were discharged.

HFEF-N

The general design philosophy of the ventilation system for a nuclear system is to provide within each area of the facility an air pattern that results in air flowing from clean areas toward areas with a possibility of contamination, and from these areas toward those with greater possibility of contamination. All radioactive airborne effluents are then processed through 30 HEPA filters. The ventilation system for HFEF-N is based on this type of philosophy.

The system is provided with two fans, each capable of handling the full load, and both are connected to emergency power. Figure II-6 shows a flow diagram of the system.

Limited operations at HFEF-N would not result in the release of noble gases. Air particulate activity during 1974 was less than the minimum detectable (10^{-14} $\mu Ci/cm^3$).

L&O Building

The design of the heating, ventilating, and air conditioning and exhaust system of the L&O building ensures that airflow is from clean areas inward toward the potentially contaminated areas to prevent the spread of radioactivity. The office section is maintained at a positive pressure with respect to the rest of the building and also provides partial makeup air for the radiochemical hoods in the laboratories. Radioactive exhaust is drawn through 20 HEPA filters in parallel and then discharged out the central 200-ft-high stack. A recent addition to the L&O building, the sodium chemistry laboratory, exhausts air through an independent system of 12 HEPA filters in parallel then out a short stack to the atmosphere. A third laboratory, utilized for handling special sodium samples, exhausts directly to the atmosphere through four HEPA filters in parallel. A fourth laboratory contains one hood with a HEPA filter.

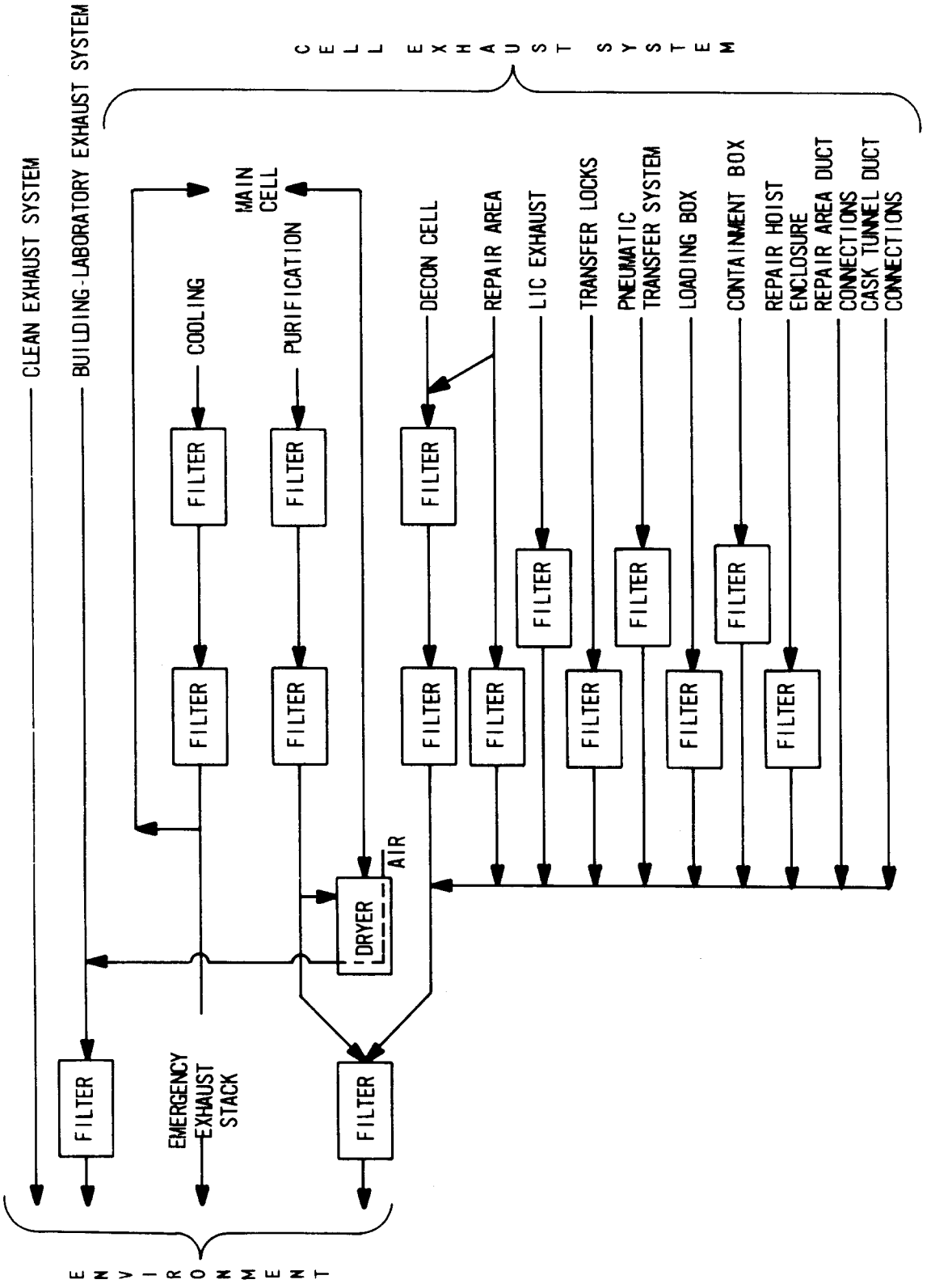

Figure II-6. HFEF-N Cell Ventilation System.

During 1974, the radioactive airborne waste stream for the L&O building discharged 0.1 Ci of iodine-131 in 9.2 x 10^9 ft^3 of air.

Main Stack

As previously noted, the major point of radioactive airborne discharge to the atmosphere is the 200-ft-high stack, centrally located in the ANL-W area. The stack is constructed of glass coated carbon steel sections gasketed and bolted together. This stack receives airborne effluent which first has been channeled through HEPA filters in the EBR-II building, HFEF-S, and L&O building. A duel blower system discharges the effluent through the stack; each blower has the capability to handle the total flow requirement. An air conditioned building at the stack base contains continuous monitoring equipment. This equipment consists of a commercially available system of scintillation detectors designed to monitor for total radioactive particulate material and total radioactive gaseous concentration, and to monitor selectively for concentrations of cesium-137, xenon-133, and iodine-131. The air conditioning system indigenous to the stack building is to assure the stability and operating range of the instrumentation.

Table II-1 presents an annual summary of radioactive airborne discharges at ANL-W. The high releases from 1965 through 1968 resulted from the fuel cycle facility which processed EBR-II fuel. This facility began operations in 1965 and was discontinued in 1969. During the 4 yr period approximately 7,500 Ci of Kr-85 were released. The majority of the remaining activity was Xe-133. The differences in the years can be attributed to the adequacy of the holdup system designed to reduce the short-lived (Xe-135, Xe-133) emissions by decay.

Table II-2 shows a nuclide summary of airborne releases from ANL-W for 1974. This table is the total ANL-West site releases and includes TREAT, HFEF/S, and EBR-II.

b. Systems for Venting Nonradioactive Airborne Wastes[a]

Nonradioactive airborne effluent from the EBR-II complex consists of boiler combustion flue gas (combustion products of petroleum fuel), sanitary waste system venting gases, cooling tower and windage losses to the atmosphere, and ventilating system discharges from nonradioactive administrative areas.

Four auxiliary boilers within the EBR-II complex furnish a central heating facility for the ANL-W area, excluding TREAT which has its own boiler system. The combustion gas effluent is discharged through stacks at an elevation of 80 ft above ground level. The combustion gases are monitored periodically for sulfur dioxide and carbon monoxide content to assure compliance with air quality standards. In 1972, fuel oil type was changed from No. 5 to No. 2 to reduce sulfur effluent. Smoke detectors are utilized in the stack to monitor combustion efficiency.

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[a] See Appendix E, Section 3.A. for system improvements completed in 1975-76.

TABLE II-1

SUMMARY OF ANNUAL RADIOACTIVE AIRBORNE DISCHARGES AT ANL-WEST

Year	Volume (ft^3)	Radioactivity (Ci)
1960	[a]	176.5
1961	[a]	106.0
1962	9.0×10^5	186.5
1963	8.0×10^5	207.0
1964	7.3×10^6	124.0
1965	7.5×10^9	18,822.0
1966	3.1×10^{10}	4,246.0
1967	2.9×10^{10}	2,757.0
1968	3.2×10^{10}	837.0
1969	2.7×10^9	130.0
1970	1.3×10^{10}	84.0
1971	7.9×10^{10}	74.0
1972	4.3×10^{10}	127.0
1973	6.0×10^{10}	803.1
1974	6.4×10^{10}	666

[a] No volumes were recorded prior to November 1961.

In 1974, a volume of 770,330 gallons of No. 2 fuel oil was burned. This resulted in 36,755 lb of sulfur dioxide (calculated) and 3,460 lb of particulates (calculated) released during the year.

The airborne effluents from the cooling tower discharges are windage losses and water vapor resulting from thermal exchange in dissipating the heat from the powerplant steam system. All airborne waste from the cooling tower is nonradioactive. The nonradioactive airborne stream contains the treatment chemicals which are lost by drift (blown by wind) from the cooling tower.

During 1974, the following quantities were lost to the atmosphere in 3.4×10^5 gallons of drift: zinc - 4 lb; hexavalent chromium - 17 lb. Worst-case calculations indicate that resultant air concentration for hexavalent chromium in the air surrounding the cooling tower is 0.04 mg/m^3 which is less than the TLV of 0.1 mg/m^3.

TABLE II-2

ANL-WEST AIRBORNE NUCLIDE RELEASE SUMMARY FOR 1974

Nuclide	Curies
Argon-41	148
Bromine-82	<1
Iodine-131	<1
Krypton-85	<1
Krypton-87	<1
Krypton-88	<1
Tritium	<1
Xenon-133	368
Xenon-135	147
Total	666

TREAT

Nonradioactive airborne effluent is produced from one steam heating boiler and one oil-fire furnace utilizing No. 2 fuel oil, and from sanitary system vents. The sulfur release was included in the EBR-II section. The sanitary waste vents discharge directly to the atmosphere.

ZPPR

The only nonradioactive airborne effluent originating from the ZPPR is from sanitary system vents which discharge directly to the atmosphere.

HFEF-S, HFEF-N, L&O, and Support Complex

The major source of nonradioactive airborne effluent from these facilities is the venting of the sanitary system which discharges directly to the atmosphere through high point vents. In addition, ventilating air from nonradioactive areas is discharged directly to the atmosphere. Also, the cafeteria cooking hoods discharge directly to the atmosphere.

Table II-3 presents an annual summary of the nonradioactive airborne discharges from ANL-W.

TABLE II-3

SUMMARY OF ANNUAL NONRADIOACTIVE AIRBORNE DISCHARGES AT ANL-W

Year	Fuel Oil Used (gal)	Sulfur Dioxide Discharged (lb)	Cooling Tower Drift (gal x 10^6)	Chromium^{+6} Discharged (lb)
1963	698,600	145,911	—	--
1964	636,600	132,925	0.24	11
1965	553,600	115,602	1.7	77
1966	565,700	118,100	2.4	108
1967	677,000	141,356	1.2	54
1968	666,100	139,078	2.0	90
1969	744,700	155,482	2.0	90
1970	726,837	166,445	3.0	135
1971	767,906	175,550	2.4	108
1972	957,748[a]	146,978[a]	3.6	81
1973	961,101	45,857	0.64	29
1974	770,330	36,755	0.34	17

[a] Sulfur content was 1.53% until September 1972; since that time, the sulfur content was 0.35%.

c. Systems for Disposal of Radioactive Liquid Waste[a]

EBR-II

No radioactive liquid waste is produced by the EBR-II operations or within the containment building except for controlled gallon-batch quantities of water/alcohol used for component decontamination purposes. This liquid is under administrative control (i.e., weighed and logged in, weighed and logged out, and totally accounted for). This liquid is disposed of as solid radioactive waste. Therefore, no liquid waste systems have been installed in the containment building. No radioactive liquid waste was produced at the reactor plant and energy dissipation system in 1974[25].

[a] See Appendix E, Section 3.A. for system improvements completed in 1975-76.

Radioactive liquid is produced by the reaction of water/alcohol with radioactive sodium which adheres to reactor components that have been in contact with the sodium systems and to primary coolant system components. Figure II-7 shows the flow diagram of the liquid collection and retention system. Design features of the system include: an impervious steel surface of the pad to prevent the buildup of radioactive materials by absorption, a 3- to 4-in. lip on three sides of the pad to prevent flow of the liquids to the surrounding soil, and a sloping surface feeding into a 2,500-gallon underground tank for the retention of any liquid. The 4-in. lip around the pad would contain about 1,500 gallons if the tank overflows and backs up onto the pad. All liquids produced in this area, including natural runoff, are collected in a tank and treated as radioactive. The internal surface of the tank has been coated with a primer that prevents corrosion and the associated drain piping has been hydrostatically tested at 50 psig. The content of the tank is measured periodically by dipstick. When the tank level reaches 2,000 gallons, it is emptied by pumping into a portable 2,300 gallon transfer tank for later transfer to the liquid waste processing system. The contents of the tank are monitored for radioactivity levels prior to pumping to a portable tank for transfer and processing at the L&O building. The radioactive waste stream consists primarily of mixed activation products and mixed fission products. During 1974, this facility produced 2.4 mCi of radioactivity contained in 6,200 gallons of water.

The only other source of radioactive liquids is from a personnel decontamination system. Liquid waste from the personnel decontamination lavatory, shower, and locker room floor drain are gravity-fed to a receiver at the foot of a pipe trench. A float controlled pump transfers these wastes to the basement of the HFEF-S building, where they are combined with the radioactive liquid wastes from the HFEF. From the HFEF, the combined liquid wastes are transferred to a collection/retention tank at the L&O building, where monitoring and processing occurs.

To date this system has not been used.

TREAT

Radioactive liquid waste from TREAT facility activities may be produced from personnel decontamination and equipment decontamination. The radioactive liquid waste disposal system is comprised of a washbasin, shower, and janitor's sink and the necessary piping and plumbing connecting to a sump. The washbasin, shower, and janitor's sink are isolated from the sanitary waste disposal system, thus eliminating any possibility of contamination of the sanitary waste system. Effluent entering this isolated liquid system is piped to a common line leading to a sump, from which the waste effluent is then pumped to a retention tank. The system is shown schematically in Figure II-8. The sump is equipped with a HEPA filtered air vent and a pump with automatic float actuation. The sump discharge piping runs above ground in the reactor building to a 1,000-gallon carbon steel retention tank. The tank is equipped with a level indicator which activates visual and audible alarms when a predetermined level is reached.

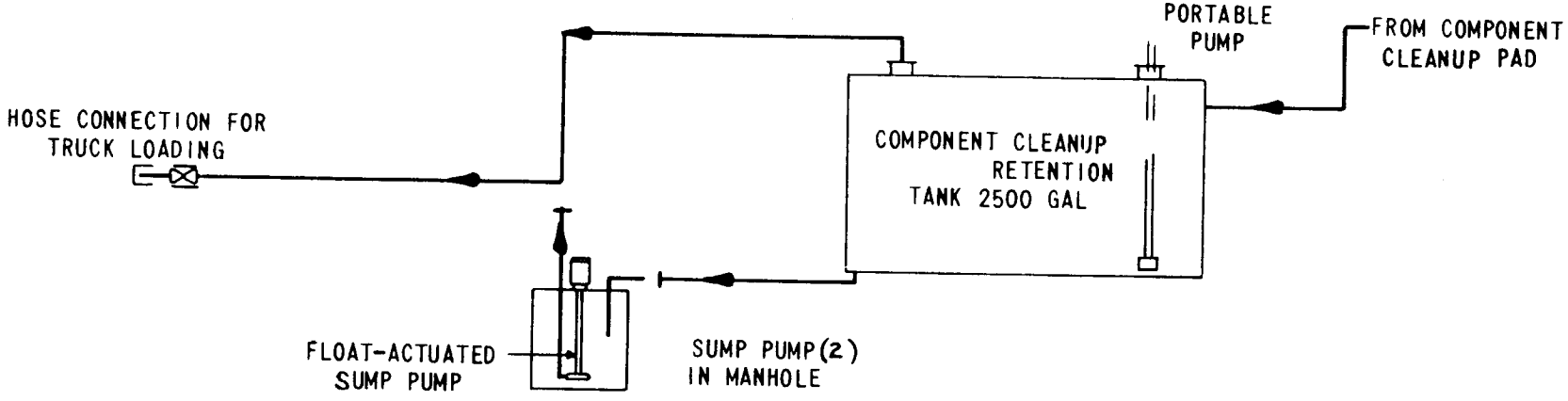

Figure II-7. Component Cleanup Facility Radioactive Liquid Waste System.

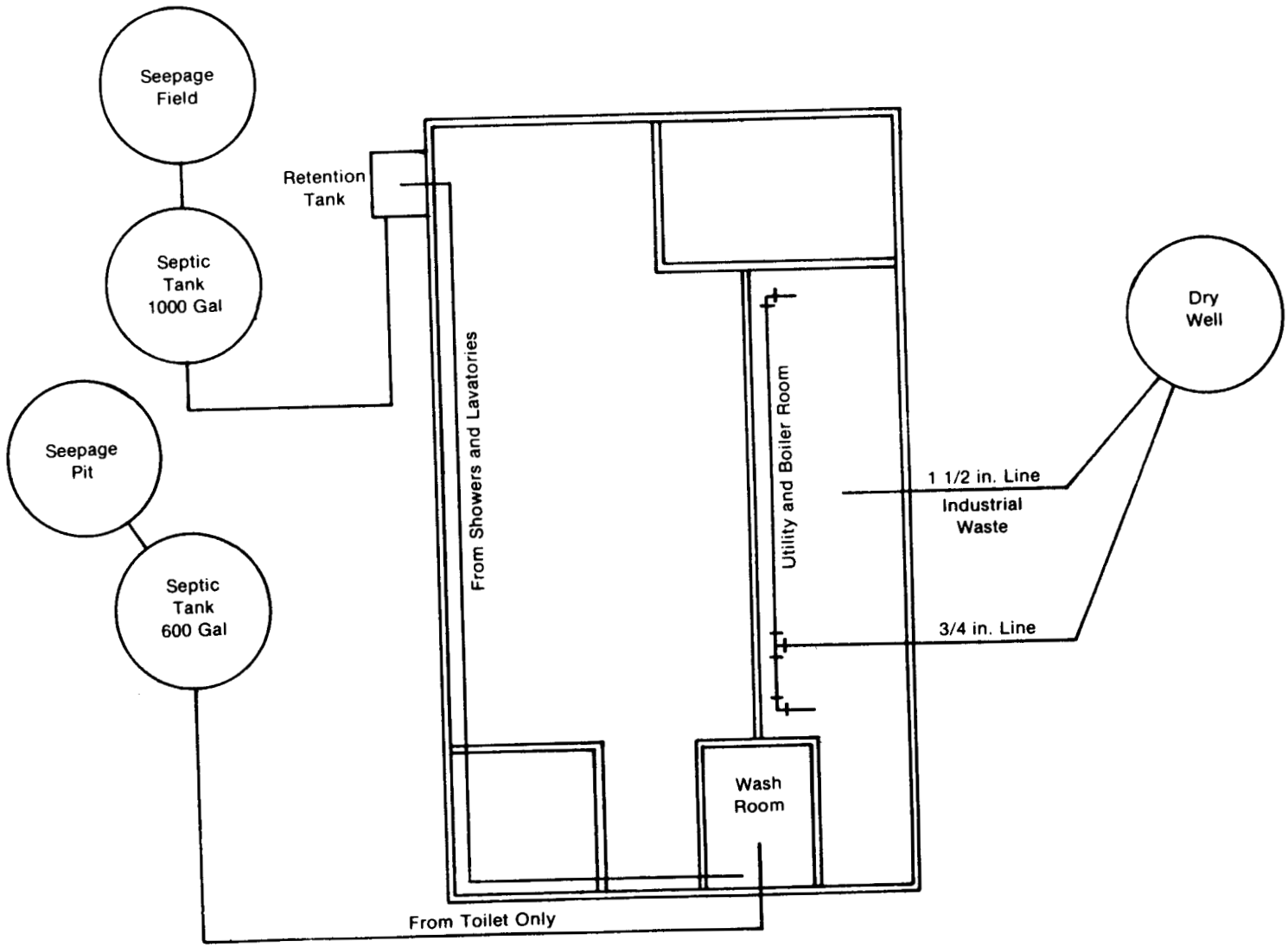

Figure II-8. Plan of Industrial and Sanitary Waste Systems - TREAT Reactor Building.

The retention tank also is provided with an air vent to a HEPA filter. It has a valved discharge line to a pump, a 6-in.-diameter flanged port for inspection purposes, a level indicator, and a sampling valve. The retention tank discharge line is connected to a 1,000-gallon capacity septic tank to which liquid discharge from the retention tank may be authorized after the liquids are determined to be nonradioactive (less than ERDAM-0524 Table II values). The septic tank discharge line is connected to a seepage field. The retention tank effluent also may be discharged to a portable truck mounted tank for transporting of radioactive liquid wastes to the L&O building evaporator.

Liquid wastes produced at the TREAT complex through 1974 contained 0.4 μCi of radioactivity.

ZPPR

The radioactive liquid waste system is shown in Figure II-9. A changeroom is provided for personnel decontamination. This room contains a shower and lavatory draining by gravity into two epoxy lined carbon steel retention tanks, each having a 500-gallon capacity, located in the basement of the support wing. The tanks are equipped with two transfer pumps and the necessary interconnecting piping and valves to provide, if the effluent is not radioactive, a discharge point to either a truck fill station or directly to the industrial waste system. If the effluent is radioactive, the portable tank is used to transport the effluent to the evaporator station at the L&O building. There is a watertight concrete curb around the retention tanks to ensure retention of up to 125% of the total capacity of the retention tanks in the event the liquid is inadvertently released from the tanks. The contents of these tanks are monitored for radioactive concentrations to determine the mode of disposal. Each tank is equipped with redundant level indicators which alarm locally and remotely when the tank contents reach approximately 480 gallons. This alarm alerts personnel to transfer the liquid to the standby tank, to determine disposition of the radioactive waste, and to execute the required disposal process.

No radioactive liquid waste was produced in ZPPR operations through 1974.

HFEF-S

Radioactive liquid waste is produced in several areas. A schematic diagram of the disposal system for this waste is shown in Figure II-10[26]. Decontamination liquids are collected in either a 300-gallon or a 30-gallon holdup tank. Both tanks are fabricated from borated glass lined carbon steel and have apparatus for sampling. Liquids from these tanks are transferred, along with other miscellaneous streams, to a 1,500-gallon glass lined stainless steel retention tank. The retention tank is equipped with a remote liquid level indicator and alarm and is located in a curbed area designed to contain the liquid in the event of a tank failure. Tank contents are monitored for total alpha prior to pumping to the L&O building evaporator.

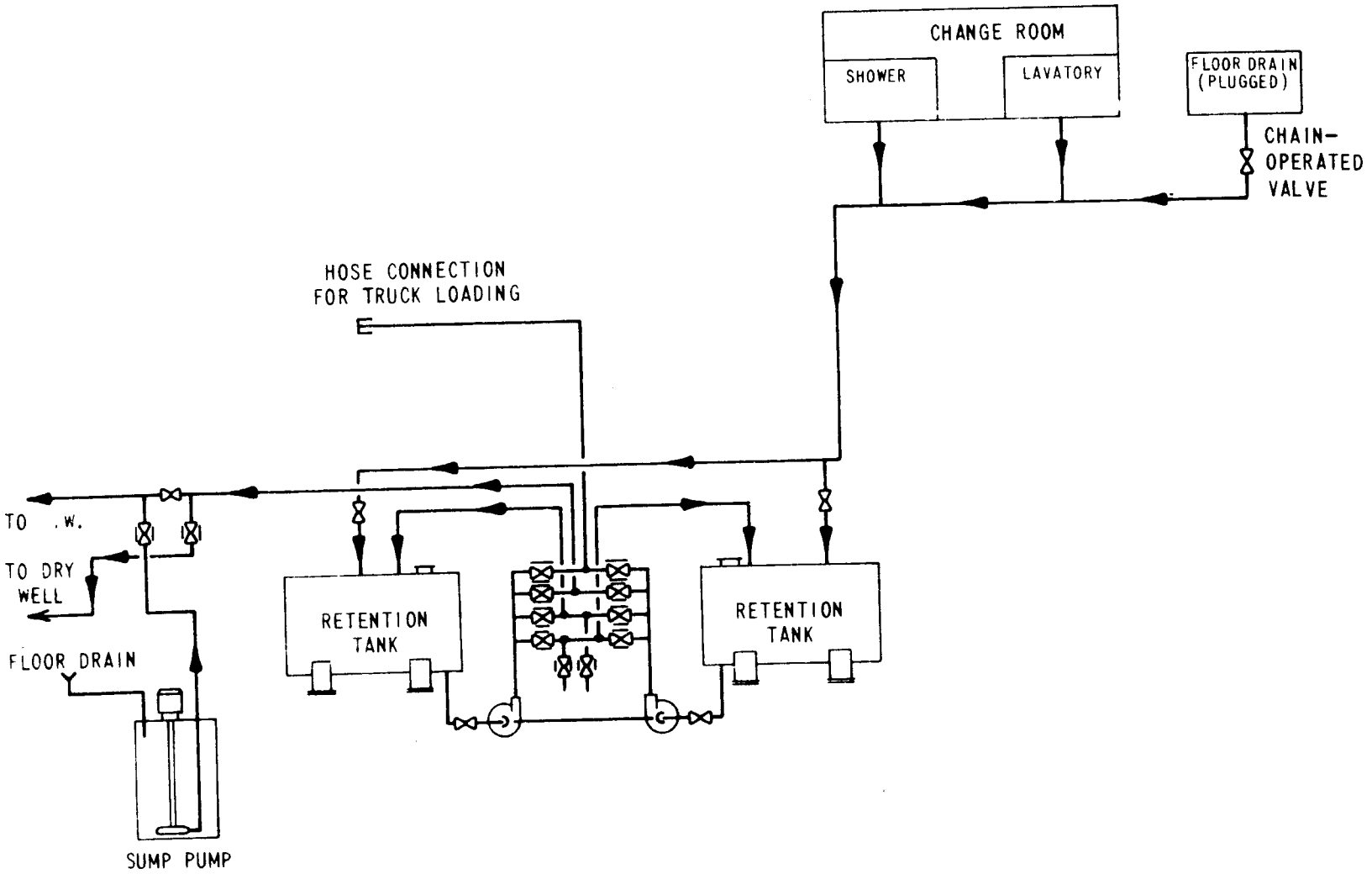

Figure II-9. ZPPR Radioactive Liquid Waste System.

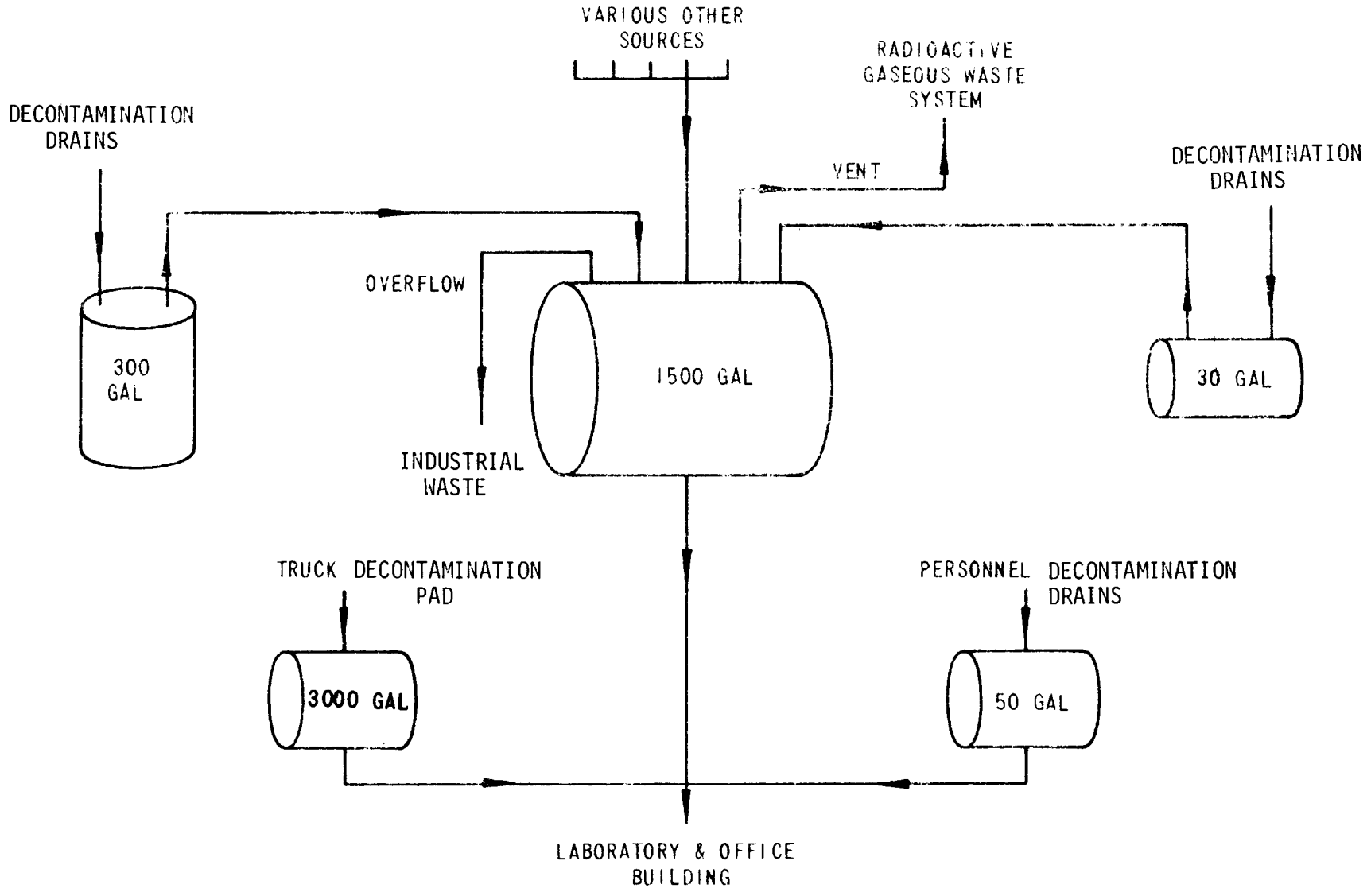

Figure II-10. HFEF-S Radioactive Liquid Waste System.

Liquid from personnel decontamination showers is collected in a 50-gallon stainless steel holdup tank and then transferred to the L&O building.

Liquid from a truck decontamination pad is collected in an underground 3,000-gallon carbon steel tank equipped with a high-level indicator and alarm and then transferred to the L&O building.

The integrity of the system is ensured by the use of stainless steel pipe with welded joints and the glass lined tank interiors. The piping and tanks periodically are hydrostatically tested to pressures consistent with operating levels. All tanks are provided with inspection ports and are periodically inspected and cleaned. The underground radioactive discharge line to the L&O building is also periodically hydrostatically tested to ensure that the integrity of the line remains effective. Aside from alpha monitoring, identification of constituents in the liquid streams occurs only after mixing with liquid waste from other sources at the L&O collection/retention tanks.

During 1974, 14,910 gallons of radioactive liquid were pumped from the HFEF-S to the L&O building collection system for processing.

HFEF-N

Potentially radioactive liquids from the laboratories, changerooms, repair area, janitor sinks, emergency shower, and eyewash station drain into a 1,500-gallon carbon steel epoxy lined retention tank. This system normally will not be radioactive, but nevertheless is sampled to determine the status. The installation and operating procedures for the liquid waste disposal system are based on the potential for determining any radioactive discharge from the above-stated areas. Other potentially radioactive streams are collected in a 1,500-gallon stainless steel decontamination drain holdup tank. Both the retention tank and the holdup tank are served by a common transfer pump and piping system. Effluent can be discharged either to a truck loading station via the existing radioactive waste line through HFEF-S (previously discussed) or into a carbon steel industrial waste pipe through HFEF-S, depending upon whether the effluent is determined to be radioactive or nonradioactive, respectively. The decontamination drain holdup tank is provided with a valved overflow into the retention tank.

Welded stainless steel piping and epoxy lined and stainless steel tank interiors provide the high integrity required for this system. Materials selected for the liquid effluent systems were based on longevity criteria. The radioactive liquid lines that are not inspectable are periodically hydrostatically tested to pressure levels consistent with operational conditions. Both tanks are sampled for radioactivity to determine the mode of disposition. The retention tank and the decontamination drain holdup tank are equipped with local liquid level indicators and high-level alarms, which sound out and alert the operations office staff. The tanks vent to the building radioactive exhaust system. Any overflow from the retention tank is directed to a recessed sump, where a pump will return the flow to the retention tank.

The radioactive liquid waste disposal system is isolated from the liquid industrial waste disposal system by valving arrangements. Also these systems are physically isolated from the sanitary liquid waste disposal system. There are no connections between the sanitary waste system and the other two systems.

Liquid wastes produced at HFEF-N during 1974 contained 46 μCi of radioactivity in 10,527 gallons.

Laboratory and Office (L&O) Building

The L&O building radioactive liquid waste system consists of a series of separate transfer lines. These lines collect radioactive liquids, or liquids suspected of being radioactive from their points of origin and transfer them to a central station for processing. All lines are constructed of stainless steel, carbon steel, or polyvinyl chloride plastic[27].

Because of processing requirements, the effluents are segregated into acid and nonacid systems. Late in 1973 a modification was made so that the acid system effluent is collected in a fiberglass retention mixing tank with a 240-gallon capacity and a level indicator. The collected acids are neutralized with caustic and then evaporated in a disposable container, with the residue disposed of as solid waste. The nonacid streams are evaporated in the same manner. Fumes produced from the radioactive liquids collected by the system are prevented from venting to the laboratory air by liquid traps at all sinks. The traps are flushed daily with clean water to prevent concentrated acids from standing in the traps. The retention mixing tank downstream from the traps is vented to the HEPA filter system. The tanks and equipment are surrounded by a curbed retention area so that any spilled liquid will be fully contained in the curbed area. Any leakage is removed by absorption materials and disposed of as solid waste. The retention area is made impervious with a suitable coating to avoid absorption of radioactive liquids into the concrete. If precipitates should accumulate in the bottom of the retention mixing tank, compressed air is used to disperse such materials so that they can be handled as liquids.

The radioactive liquid waste effluent is not monitored prior to mixing with effluent from other facilities.

d. Systems for Processing Radioactive Liquid Wastes

The radioactive liquid waste from all facilities at ANL-W is transported either through underground pipes or by means of portable tanks to retention tanks at the evaporator located at the L&O building. The liquid is received in one of two 2,900-gallon carbon steel settling tanks. When this tank is full, the waste is pumped through a welded stainless steel piping and filter system to one of two 1,500-gallon glass lined evaporator feed tanks. Both feed tanks are equipped with high-level indicators which activate local and remote visual and audible alarms. The effluent is then pumped from this feed tank to the evaporator through stainless steel welded pipe.

The evaporator is a commercially available natural circulation-type system composed of two main parts: the heat exchanger and the flash chamber. The evaporator can process a 1,500-gallon batch at a design capacity of 260 gallon/hr with a measured decontamination factor of between 10^2 and 10^4, depending upon the concentration of the feed. A safety feature of the evaporator is an in-line radioactivity detector for monitoring the condensate of the heating steam. If concentrations reach a predetermined alarm point, an alarm is sounded both locally and remotely at the reception building.

The vapor from the evaporator is carried overhead first through a condenser and then a cooler. The vapor thus is transformed in a condensate. The condensate flows to an evaporator condensate tank, which is also a 1,500-gallon glass lined carbon steel tank. The condensate then is processed through ion-exchange columns and collected in a plastic lined, 1,600 gallon carbon steel retention tank. Processed condensate is sampled and analyzed for residual radioactivity. Nonradioactive condensate is pumped to the industrial waste pond, and radioactive condensate is recycled.

All condensate discharged to the industrial waste pond is monitored continuously by an in-line monitor that alarms both locally and remotely at the reception building, which is occupied at all times. Alarm results in notification of waste management personnel, who institute prescribed procedures to correct the situation.

A seepage pit served as the final receiver for low-level radioactive liquid condensate until October 1973, when use of the pit was discontinued. The pit is 37 ft long x 18 ft wide x 10 ft deep and is covered with an 8-in.-thick concrete slab which protects it from weather and ingress of wildlife. The pit is not utilized at the present time.

The concentrated waste in the bottom of the evaporator heat exchanger is transferred by gravity to a 55-gallon carbon steel disposable concentrator drum. Any remaining liquid in the residue is evaporated with an expendable copper steam coil, which remains with the residue at the time of disposal. The vapor from the concentrator drum is mixed with dry air and channeled through 20 HEPA filters in parallel, then through the L&O exhaust system to the 200-ft-high stack.

The radioactive liquid waste stream from the evaporator contains trace amounts of fission and activation products. Radioactivity concentrations are below ERDA radiation protection standards for release to uncontrolled areas.

During 1974, radioactivity in 9.7×10^4 gallons of treated water discharged to the industrial waste pond was less than 10 μCi of alpha and less than 8 μCi of beta activity, exclusive of tritium. Tritium discharged in this volume totaled 30 μCi. Table II-4 shows a summary of annual radioactive liquid discharges at ANL-W.

TABLE II-4

SUMMARY OF ANNUAL RADIOACTIVE LIQUID DISCHARGES AT ANL-W

Year	Volume (gal)	Radioactivity (Ci)
1960	-0-	-0-
1961	518,875[a]	0.00005
1962	21,530	0.00037
1963	29,500	0.00008
1964	25,650	0.0139
1965	27,220	1.017
1966	45,480	0.398
1967	60,000	1.692
1968	67,000	0.640
1969	80,000	3.087
1970	75,000	3.320
1971	78,000	0.164
1972	69,000	0.025
1973	73,000	0.038
1974	97,000	0.030

[a] Includes dilution water for 2 months.

e. Systems for Processing Nonradioactive Liquid Wastes

EBR-II

Nonradioactive effluent consists of sanitary waste associated with personnel occupancy and of the industrial waste generated by the operation of air compressors, pumping systems, auxiliary boilers, reactor plant auxiliaries, air conditioning equipment, and cooling towers.

Sanitary waste is routed internally in the EBR-II complex through cast iron pipe to the sewer, which discharges to the sanitary lagoon. The industrial waste effluent is combined with the blowdown effluent from the cooling tower. This combined effluent flows to an interceptor canal, then to the industrial waste pond. Sanitary and industrial wastes are not measured until after mixing with effluent from other facilities, with the exception of auxiliary boiler blowdown. During 1974, 38 lb of sodium sulfite and 32 lb of sodium phosphate were released to the industrial waste pond in 12,950 gallons of blowdown[28].

Cooling tower liquid effluent is comprised solely of nonradioactive industrial waste produced from chemical treatment of the steam cooling system makeup water. This effluent, generally referred to as "blowdown," is extracted from the main cooling water supply line to the condenser. The blowdown flows to a sulfur dioxide treatment tank (where the hexavalent chromium ion is chemically reduced to trivalent chromium) prior to discharge.

During 1974, the following quantities were discharged to the industrial waste pond in 1.9×10^7 gallons of blowdown water: zinc - 144 lb; $chromium^{+3}$ - 602 lb; calcium sulfate - 41,071 lb; and sodium hydroxide - 11,100 lb.

TREAT

Approximately 300,000 gallons of raw water are supplied annually to the TREAT facility, which produces approximately 160,000 gallons of industrial waste and 140,000 gallons of sanitary waste annually. A sketch of the industrial and sanitary waste effluent systems is shown in Figure II-8.

The industrial waste effluents are discharged into a dry well with an underlay of coarse gravel. The well is located east of the reactor building. Of the total annual industrial effluent, approximately 600 gallons are produced per year as boiler blowdown, which contained 3 lb of Nalco-35 and 4.5 lb of phosphate during 1974.

Separate sanitary waste disposal systems are provided for the reactor building and for the control building. The system for the reactor building consists of a septic tank which discharges into a seepage pit. The sanitary system for the control building consists of a 1,000-gallon septic tank which also drains into a seepage pit.

ZPPR

Nonradioactive liquid wastes consist of sanitary waste and the industrial waste produced by the cooling/process water for the compressor, air conditioning, and other rotating machinery. All industrial waste effluents are collected in holding tanks and analyzed prior to discharge. After analysis, the industrial waste is discharged to the industrial waste ditch, then by gravity flow to the interceptor canal, and finally to the industrial waste pond.

HFEF

Nonradioactive liquid effluent consists of sanitary waste and industrial wastes at both HFEF-N and -S facilities. The sanitary waste effluent is pumped to the sanitary lagoon. The industrial waste effluent is discharged to a ditch which drains to the industrial waste pond. Several floor drains in the HFEF-S clean area drain directly into the industrial waste system.

L&O Building

Sanitary waste produced also is pumped to the sanitary lagoon. Industrial wastes are collected, monitored, and, if nonradioactive, are transferred to the waste pond via the interceptor canal.

Sanitary Lagoon

The sanitary lagoon (Figure II-3), located about 1,000 ft north of the ANL-W building facilities, receives all sanitary wastes from the ANL-W building facilities, except from the TREAT facility. The lagoon consists of three open ponds having a combined area of 2.3 acres. Sanitary waste effluent is piped into the first pond, then overflows to the second and third ponds. The bottom of the lagoon is sealed with Bentonite to minimize seepage into the underlying strata. This lagoon serves as a final receiver for sanitary wastes. The effluent in the sanitary lagoon is sampled on a monthly schedule for determination of acidity (pH), biological oxygen demand (BOD), and dissolved oxygen (DO). All sanitary effluent is monitored continuously for radioactivity; and if radioactivity levels exceed a predetermined setpoint of 2.0×10^{-5} μCi/ml, an alarm sounds locally and remotely at the reception building.

The data listed in Table II-5 were recorded during the nonfreezing months of 1974. A total of 2.9×10^{6} gallons of water was discharged to the sanitary lagoon during 1974. Table II-6 presents a summary of the annual nonradiological liquid discharges of the ANL-W facility.

TABLE II-5

ANL-W SANITARY LAGOON ANALYSIS FOR NONFREEZING MONTHS IN 1974

	BOD		pH		Dissolved Oxygen	
Month	Raw	Final	Raw	Final	Raw	Final
June	123.3	45.3	7.89	8.66	0.00	4.89
July	105	44.4	8.77	8.18	0.05	0.00
August	144	36.3	6.04	6.04	0.00	5.28
September	97.8	35.8	8.45	8.23	0.04	0.04
October	114	37.3	7.84	8.77	2.94	0.02

Industrial Waste Pond

The industrial waste effluent from all of the ANL-W buildings, excluding the TREAT facility, is piped to drainage ditches which discharge to the industrial waste pond. The pond located north of the ANL-W complex is a 3-acre evaporative seepage pond fed by a surface interceptor canal into which other ditches drain. Industrial waste waters from areas of potential radioactive contamination are monitored before being discharged to the pond.

TABLE II-6

SUMMARY OF ANNUAL NONRADIOACTIVE LIQUID DISCHARGED AT ANL-W

	Sanitary Waste[a]			Industrial Waste		
Year[b]	Gallons x 10^6 ANL-W	BOD	Gallons x 10^6 TREAT	Gallons x 10^6	Pounds of Cr^{+3}[c]	Pounds of Calcium Sulfate x 10^3
1962	0.60	-	0.12	-	-	-
1963	0.60	-	0.13	-	-	-
1964	0.72	123	0.13	9.6	51	8.8
1965	0.96	213	0.14	19.2	305	57.6
1966	0.24	169	0.14	26.1	525	93.1
1967	1.20	124	0.14	25.2	236	42.4
1968	2.20	42	0.14	46.0	540	89.6
1969	2.81	57	0.14	34.2	596	94.4
1970	2.88	39	0.14	46.1	861	139.6
1971	3.00	34	0.14	41.2	678	110.5
1972	3.03	48	0.14	42.1	386	135.4
1973	2.80	46	0.14	38.7	701	22.9
1974	2.90	40	0.14	31.5	602	41.1

[a] ANL-W, except for TREAT, discharges to the sanitary lagoon and the water is metered. TREAT uses a septic tank at the control room and another one at the reactor. The sanitary waste is not metered, and the numbers presented are estimated based on 20 gal per person per day. No BOD data are presented for TREAT.

[b] Prior to 1962, metering devices were not available for collecting information.

[c] In 1964 and 1965, the Cr^{+6} was not reduced to Cr^{+3} prior to discharge. Numbers for these years represent pounds of Cr^{+6} in industrial waste.

The following amounts of chemicals, in addition to those previously described, were discharged during 1974 to the industrial waste pond in 3.15×10^7 gallon of water:

(1) Sodium thiosulfate - 270 lb

(2) Ammonium chloride - 37 lb

(3) Sodium sulfite - 30 lb

(4) Acetic acid - 8 lb

(5) Boric acid - 34 lb

(6) Hydroquinon - 88 lb

(7) Paraformaldehyde - 29 lb

(8) Photographic color processing chemicals - 380 gallons

(9) Ferric chloride solution - 20 gallons

(10) Xylene-containing liquids - 17 gallons.

Table II-6 presents a summary of annual industrial waste discharge from the ANL-W complex.

f. Systems for Disposal of Radioactive Solid Wastes

EBR-II

A major source (by volume but not by activity) of solid radioactive waste is the accumulation of wipe rags, plastic containers, shoe covers, and other industrial solids associated with working with radioactive materials. Reactor components such as thermocouples, nuts and bolts, and other hardware are disposed of as solid radioactive wastes. Radiation from these components is generally low-level (less than 10 mR/hr). The components are collected and packaged in polyethylene bags or cardboard boxes for disposal. Radiation levels and smears of the bags and boxes are taken to ensure that there is no loose contamination or excessive radiation levels. The containers are transported to the INEL Radioactive Waste Management Complex in special vehicles (dumpsters). Dumpsters and transport vehicles are surveyed by taking smears and by measuring the radiation levels to ensure that no loose contamination exists and that radiation levels are within INEL limits.

In 1974, 870 ft^3 of low-level radioactive solid waste were produced containing 20 μCi of mixed fission products and mixed activation products.

TREAT and ZPPR

The sources of solid radioactive waste at the TREAT and ZPPR facilities are similar to that at the EBR-II. In 1974, 180 ft^3 of solid waste containing 3 μCi were produced at TREAT, and 316 ft^3 containing 15 μCi were produced at ZPPR.

HFEF-N and HFEF-S

The HFEF-N and -S facilities produce and dispose of radioactive solid wastes with low gamma radiation levels in a manner similar to that at the EBR-II. In addition, waste material greater than 100 mR/hr is produced from the disassembly and inspection of subassemblies, fuel cladding scrap and discarded equipment items, and high gamma level waste and plutonium contained in reactor blanket subassemblies. The high gamma level waste and plutonium bearing materials are stored in the Radioactive Scrap and Waste Facility, which is described in Section II.A.9.

During 1974, 5,310 ft^3 of low-level waste containing 134 Ci of mixed fission/activation products were produced at HFEF-S and disposed of at the INEL Radioactive Waste Management Complex. Solid radioactive waste produced at HFEF-N in 1974 contained 0.2 μCi in a volume of 18 ft^3.

L&O Complex

Low-level radioactive solid wastes are produced and disposed of at the L&O complex in a manner similar to that at the EBR-II. High intensity gamma emitting waste produced in this complex is a result of chemistry sample preparation and of liquid waste evaporation and concentration which have been described previously under the Section II.A.1.c entitled, "Systems for Disposal of Radioactive Liquid Wastes." This waste is packaged in specially designed containers for disposal.

In 1974, the L&O complex produced 3,560 ft^3 of solid radioactive waste containing 576 Ci of activity. The quantities of low-level radionuclides disposed of in 9,535 ft^3 of waste at the INEL Radioactive Waste Management Complex in 1974 are listed in Table II-7.

Radioactive solid waste stored at the ANL-W Radioactive Scrap and Waste Facility in 60 ft^3 of material is listed in Table II-8. Table II-9 summarizes the annual amounts of solid wastes (a) sent to the INEL Radioactive Waste Management Complex from ANL-W from 1960 through 1974 and (b) stored at the aforementioned ANL-W storage facility, which is discussed in greater detail in Section II.A.9.

g. Systems for Disposal of Nonradioactive Solid Wastes

Nonradioactive solids are similar for all facilities at the ANL-W complex. These are comprised of wastepaper, rags, wood, and metal materials associated with administrative office work and plant maintenance operations. These wastes are collected manually and transported in dumpsters to the CFA sanitary landfill. Wastes disposed

TABLE II-7

RADIONUCLIDES IN ANL-W LOW-LEVEL SOLID WASTE IN 1974

Nuclide	Ci
Cerium-144	5.625
Cesium-137	7.876
Mixed activation products	88.76
Mixed fission products	457.7
Plutonium-239	1.040
Plutonium-240	1.078
Strontium-90	147.9
Uranium-235	0.0037
Uranium-238	0.026
Total	710.0

TABLE II-8

RADIOACTIVE SOLID WASTE STORED AT ANL-W IN 1974

Nuclide	Ci
Chromium-51	19,090
Cobalt-58	8,616
Cobalt-60	47,920
Manganese-54	10,170
Mixed activation products	5,744
Total	91,540

TABLE II-9

SUMMARY OF ANL-W ANNUAL RADIOACTIVE SOLID WASTE

Year	Solid Waste to INEL Subsurface Disposal		Radioactive Scrap and Waste Facility	
	Ci	Ft^3	Ci	Ft^3
1960	4.7	856		
1961	78.7	2,127		
1962	454.5	1,371		
1963	2.9	1,910		
1964	415.0	1,726		
1965	388.8	8,081	760,797	234
1966	4,160.0	12,100	2,454,465	558
1967	11,007.0	19,506	1,492,504	454
1968	20,733.0	16,952	1,878,902	321
1969	7,040.0	15,550	950,961	175
1970	2,122.5	12,315	671,900	64
1971	3,311.0	14,850	476,700	107
1972	40.5	11,900	274,000	145
1973	850.1	16,710	438,300	82
1974	707.9	9,535	91,540	60

in 1974 contained 4,340 yd^3 of trash, 196 yd^3 of cafeteria garbage, 143 yd^3 of wood and scrap lumber, 12 yd^3 of masonry and concrete, 8 yd^3 of scrap metal, and 590 lb of chemicals.

2. Naval Reactors Facility (NRF)

The NRF site is approximately 8 mi north of the CFA. It contains three operating naval reactor prototypes, the Expended Core Facility (ECF) and administrative and support functions. Westinghouse Electric Corporation (WEC) operates these facilities for ERDA. Figure II-11 is a perspective view of NRF.

The S1W reactor plant, originally the prototype for the nuclear powered submarine NAUTILUS, has been in operation since 1953 and was the first reactor plant constructed at NRF. S1W presently is used to test naval nuclear reactors and nuclear reactor components and to train U. S. Navy personnel for service on nuclear powered ships.

The A1W reactor plant is the prototype for the aircraft carrier ENTERPRISE. It has been in operation since 1959. A1W is a two reactor plant in which two cores are installed and operating. The A1W plant also is used to train Navy personnel.

The S5G reactor plant, the newest of the NRF plants, became operational in 1966. S5G is the prototype in which waterflow through the nuclear reactor is by thermal circulation rather than by pumps. The plant was designed, constructed, and operated by the General Electric (GE) Company until 1972, when the WEC became responsible for its operation. This plant also is used to train Navy personnel.

The ECF, which became operational in 1958, is a large facility for examining, measuring, and testing components that have been irradiated in nuclear reactors. Also in this facility structural material from expended naval core fuel modules is removed. After separation, the structural parts are transported to the INEL Radioactive Waste Management Complex for disposition, and the expended fuel is transferred to the ICPP for reprocessing and recovery of fissile material.

a. Systems for Venting Radioactive Airborne Wastes

The potential source of airborne radioactivity associated with the prototypes of the NRF complex is the radioactivity contained in the reactor coolant systems. These systems contain neutron activated corrosion and wear products, activated impurities in reactor coolant, and small quantities of fission products from trace impurities of natural uranium in reactor structural materials. Radioactivity might be released and become airborne if a reactor coolant leak should occur; release also might occur during sampling operations, during maintenance and overhaul operations which require opening the system, or while working on contaminated components removed from the system. The possibility of radioactivity becoming airborne is minimized by the high integrity of naval reactor fuel elements and primary coolant systems. In addition, stringent radiological controls developed during 20 yr of prototype operation at NRF are applied during all operations in order to ensure the least possible release of airborne radioactivity.

1-BOILER HOUSE
2-ADMINISTRATION BUILDING
3-S5G TEST PLANT BUILDING
4-AIW OPERATIONS BUILDING
5-EXPENDED CORE FACILITY
6-GATE HOUSE
7-S5G COOLING TOWER
8-AIW COOLING TOWER
9-SEEPAGE BASIN
10-SEWAGE LAGOON
11-NAVY TRAINING BUILDING
12-SWITCHGEAR BUILDING
13-MAINTENANCE SHOP
14-WAREHOUSE
15-SIW COOLING POND
16-SIW BUILDING

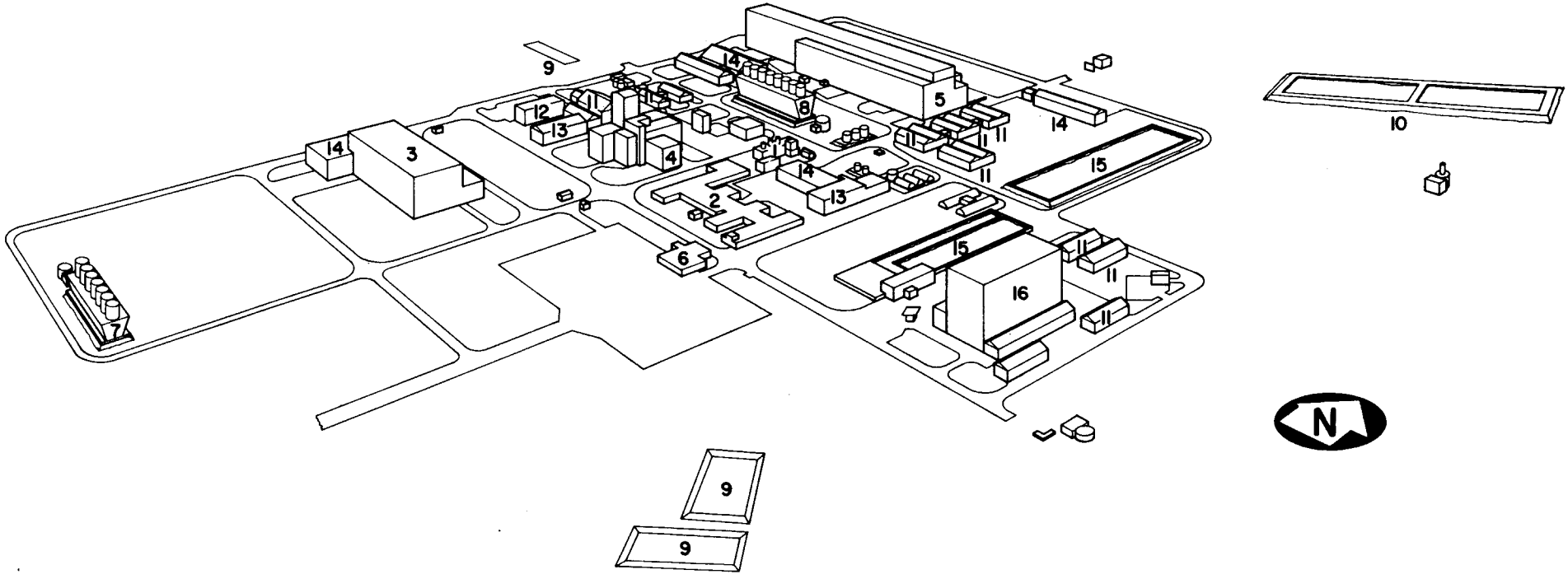

Figure II-11. Perspective View of the NRF.

(1) Particulate Releases

In ECF, where expended naval reactor core components are routinely handled, the potential exists for airborne particulate release. Consequently all air to be vented from the facility first is passed through HEPA filters with 99.97% efficiency for particulate removal and/or charcoal filters. Monitoring is continuous to enable rapid shutdown of ventilating equipment in the unlikely event that airborne particulate activity exceeds a concentration limit of 1×10^{-10} $\mu Ci/cm^3$. This limit is based on the radioactivity concentration guide listed in AECM (ERDA) Chapter 0524[7] for airborne release to an unrestricted area of insoluble cobalt-60, the predominant radioactive isotope associated with NRF operations.

To calculate particulate releases conservatively, all air released is assumed to have a concentration equal to the minimum detectable activity of the detection system. On this basis NRF particulate releases in 1974 totaled only 0.2 millicurie.

NRF has been installing improved fixed filter samplers on all exhausts which might release airborne particulate radioactivity. This improved monitoring capability provides the ability to detect releases at all locations down to concentrations of 1×10^{-15} $\mu Ci/cm^3$, which is below natural background at NRF.

(2) Gaseous Releases

Gaseous radioactivity at NRF is produced by neutron activation of gaseous impurities in reactor coolant, by production of tritium (12.3-yr half-life) from neutron capture in naturally occurring deuterium in the coolant, and by fission of the trace impurities of natural uranium in reactor structural materials. These gases are released when reactor coolant systems are drained or sampled. The principal isotopes produced, in addition to tritium mentioned above, are argon-41 (1.8-hr half-life), xenon-133 (5.3-day half-life), and krypton-85 (10.7-yr half-life). The total release of argon-41 during 1974 was 0.00011 Ci. Within 24 hr this activity has decayed to one one-thousandth of its release concentration, and it is of little environmental significance. Xenon-133 releases are much smaller. During 1974, there were 2 Ci of krypton-85 released from NRF.

b. System for Venting Nonradioactive Airborne Wastes

A source of nonradioactive airborne waste is the burning of fuel for heating purposes. This produces sulfur dioxide particulates, etc. Typical amounts are shown in Table II-10. Other sources of nonradioactive airborne waste include an incinerator, cooling towers, and various chemistry hood exhausts.

TABLE II-10

1974 NRF NONRADIOACTIVE AIRBORNE RELEASES

Boiler stack discharge:	
Fuel burned, gallons x 10^6	1,700,000
Sulfur dioxide, lb	523,000
Particulates, lb	29,000

c. System for Disposal for Radioactive Liquid Wastes

(1) Sources of Liquid Radioactive Wastes

The principal source of radioactivity in liquid wastes from NRF pressurized water reactor (PWR) prototypes is from trace amounts of neutron activated corrosion and wear products. These products originate from metal surfaces which are in direct contact with reactor coolant water.

Radionuclides in these corrosion and wear products with half-lives greater than 1 day include chromium-51, manganese-54, iron-55, iron-59, cobalt-58, cobalt-60, zirconium-95, antimony-125, hafnium-181, tantalum-182, and tungsten-187. The predominant and longest-lived of these radionuclides is cobalt-60, which has a 5.25-yr half-life.

The reactor coolant also contains short-lived radionuclides with half-lives ranging from seconds to hours. The highest concentrations of these radionuclides in reactor coolant are nitrogen-16 (7-sec half-life), nitrogen-12 (10-min half-life), fluorine-18 (1.8-hr half-life), argon-41 (1.8-hr half-life), and manganese-56 (2.6-hr half-life). For the longest-lived of these, the concentration is reduced to one one-thousandth of its initial concentration one day after transfer from the operating plant to the radioactive waste processing system, and the concentration is reduced to one one-millionth in about two days. Because of their small amounts and rapid decay, short-lived radionuclides are insignificant compared with long-lived radionuclides for waste disposal considerations, and they will disappear during tank holdup of waste for processing.

Fission products, including radioactive isotopes of krypton and xenon, are retained within the cladding of naval fuel elements. Naval reactor fuel elements are tested thoroughly to confirm their ability to maintain integrity under operating and abnormal conditions under the effects of radiation. On the basis of these tests and the past successful operation of naval reactor cores, fuel element defects which could release significant fission product radioactivity to the coolant are not expected. However, trace amounts of fission products do appear in NRF prototype reactor coolant following fission of the natural uranium impurity in the zircaloy fuel cladding. The impurity level of natural

uranium in zircaloy is about 1 ppm. The concentration in the reactor coolant of fission products from the uranium impurity is so low that the total radioactivity, caused by the long-lived fission product radionuclides strontium-90 and cesium-137, is small in comparison with the radionuclides from corrosion and wear products.

During prototype reactor operation, daily monitoring of the radioactivity in reactor coolant almost invariably establishes that the low concentrations projected are not exceeded. The data to date show that no significant fission products occur in the reactor coolant, even if fuel element defects were to exist in the prototype reactor core. The data also confirm the effectiveness of the fabrication methods, quality control, and the extensive fuel element inspection processes used in naval reactor prototypes. In the event that defects in fuel elements ever should occur, additional fission products could be released to the coolant. However, NRF radioactive waste processing systems are designed with storage and processing capacity sufficient to reduce such activities to the low levels which are consistent with established release limits.

Small amounts of tritium (12-yr half-life) are formed in the reactor coolant system, principally from neutron interaction with the naturally occurring deuterium present in the coolant water (approximately 0.015%). Tritium is produced also in small quantities within the fuel element as a natural result of the fission process, but is prevented from escaping to the coolant water by the fuel element cladding material.

(2) Description of the Radioactive Liquid Waste System

NRF restricts the discharge of significant waterborne radioactivity to the environment by operating a separate processing system in each of the four facilities. A typical improved prototype processing system is shown in the simplified block diagram of Figure II-12. These improved systems were installed in S1W, A1W, and S5G in 1971 and their operation reduces radioactivity concentrations in waste effluents to minimum practicable levels. The effluents are discharged after treatment to the two seepage basins shown in the site plan in Figure II-11. In 1974, the total radioactivity released in liquid effluent was about 0.001 Ci, exluding tritium. The average radioactivity concentration was 5.9×10^{-7} μCi/ml. The average release concentration meets the stringent release criterion for an unidentified radionuclide to a controlled area as specified in AECM (ERDA) Chapter 0524. To maintain radioactive releases in liquids at levels which are "as low as practicable," the NRF waste management system incorporates the principal features listed below:

(a) In the reactor plant systems, the discharged waste water is processed directly through a series of filters and ion exchangers and into holding tanks. The filters are of the activated charcoal and standard cartridge filter types. The ion-exchange media consist of various types of resins that remove soluble radioactivity. Each system has a pre-processing storage tank which can be used in the unlikely event that the volume of water to be processed exceeds the capabilities of the system.

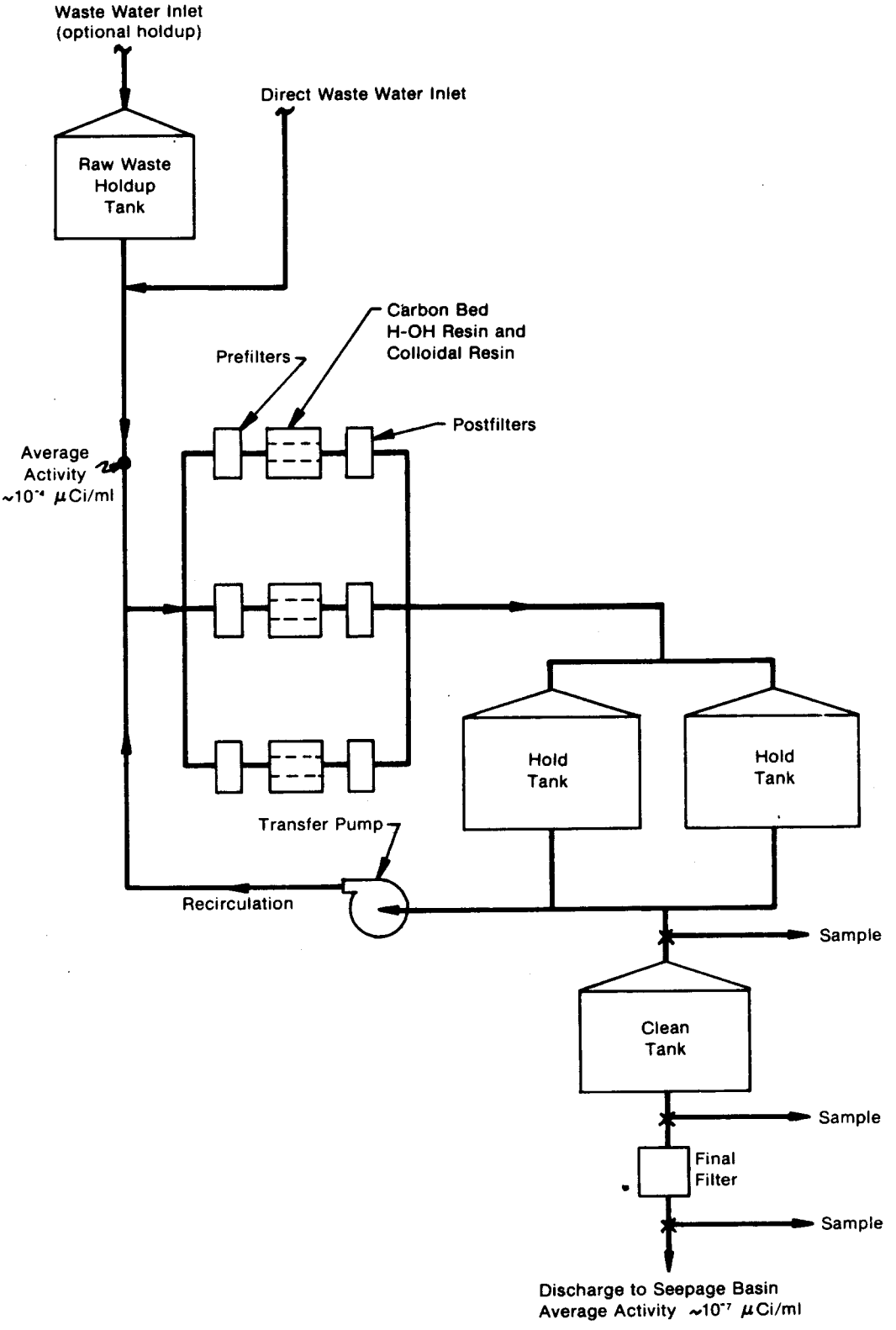

Figure II-12. Typical NRF Liquid Radioactive Waste Processing System.

(b) After processing and transfer of waste water to the hold tank, a sample is drawn and analyzed to determine if its radioactivity concentration is below the release limit of 1×10^{-6} $\mu Ci/cm^3$. If the sample meets the specification, the water is tranferred to the "clean" tank; otherwise, the water is reprocessed until it meets the release specification.

(c) Before water from the "clean" tank can be released, a sample must be drawn, analyzed, and still be below the release limit.

(d) Administrative control requires that cognizant management must approve the release in writing only after the results of the "clean" tank sample are examined.

(e) Samples are taken during release, downstream of the final filter to assure that the radioactive concentration is still below specification and to obtain a representative sample for final analysis.

(f) If any one of these samples is above specification, the release is stopped immediately.

The processed water is released to one of the two seepage basins shown in Figure II-11. The basins, which are fenced to prevent entry by wildlife, are pits dug in the earth and either rock covered or dirt and rock covered.

A similar waste processing system was installed in 1972 at ECF, except that the processed effluent is reused in ECF operations. Water is continually processed through Celite filter cakes and passed through ion-exchange resins for soluble activity removal. Some of this water is processed through another H-OH resin, a final filter, and then to the reuse tank, where it is available for reuse in ECF operations. Operation with this system has eliminated liquid waste discharges from ECF in 1973. Figure II-13 shows the significant reductions in the volume and radioactivity in liquids released in recent years.

Processed radioactive wastes are directed to the seepage basins shown in Figure II-11, which are adjacent to the NRF site. The general character of the wastes is that of filtered, deionized water with a radioactivity content less than 1×10^{-6} $\mu Ci/ml$ gross activity, less tritium. Table II-11 shows a typical distribution of measured activity in prototype releases in 1974.

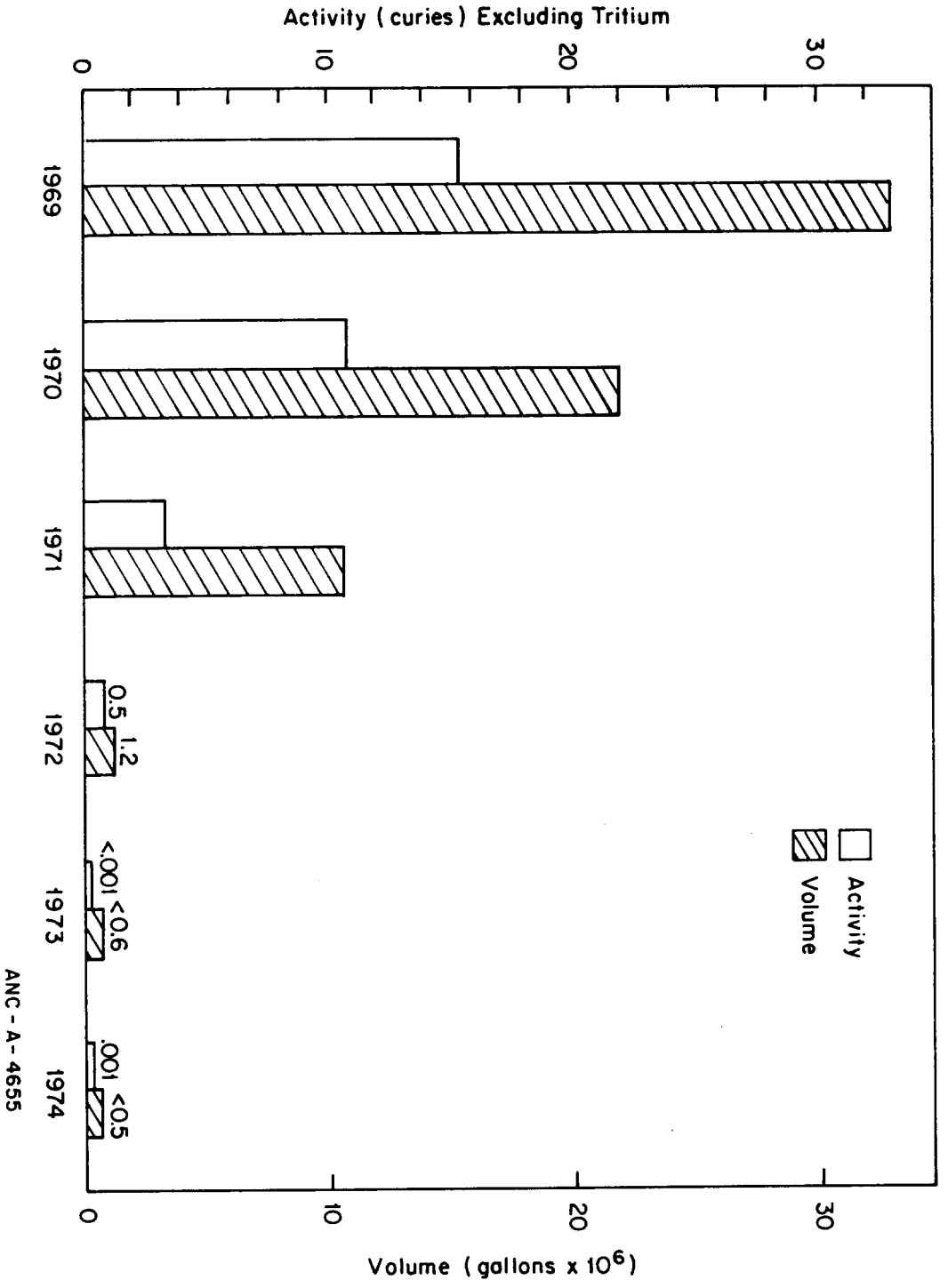

Figure II-13. NRF Liquid Radioactive Waste Releases 1969-1974.

TABLE II-11

MEASURED DISTRIBUTION OF ACTIVITY RELEASED TO SEEPAGE BASINS[a]

EXCLUDING TRITIUM

Nuclide	Fraction (%)
Antimony-124	0.25
Carbon-14	38.6
Cerium-144	1.2
Cesium-137	1.3
Cobalt-60	4.4
Silver-110	1.7
Unidentified beta-gamma	53.5

[a] Data obtained from NRF liquid waste for 1974 reported by INEL WMIS. Trace amounts (<0.1%) of cobalt-58, cesium-134, and unidentified alpha were also detected.

Carbon-14 is the principal radioactive isotope identified in this liquid, and the release concentration is a factor of more than 1,000 below the permissible concentration of soluble carbon-14 to an unrestricted area[7]. A summary of the annual releases of radioactive liquids to NRF seapage basins since 1952 is given in Table II-12.

The environmental effect of releasing liquid to the seepage basin is localized to the rock covered basin. The rock covering restricts the release of airborne radioactivity when liquid evaporates naturally from the basin. Table II-12 indicates that about 347 Ci have been released to NRF seepage basins since 1952, and it is estimated that there are approximately 167 Ci remaining in the basins after accounting for decay of the released radionuclides. Access by personnel or large wildlife to the basins is restricted by a fence surrounding the basin.

TABLE II-12

ANNUAL RELEASE OF RADIOACTIVITY IN LIQUIDS TO NRF SEEPAGE BASINS

Year	Volume (Gallons x 10^6)	Activity (Excluding Tritium) (Ci)	Activity Tritium (Ci)
1952	-	-	-
1953	3	1	0.1
1954	10	1	0.1
1955	10	5	0.1
1956	11	3	0.1
1957	12	5	0.1
1958	14	30.6	0.4
1959	17	8.6	0.4
1960	22	30.6	0.4
1961	25	30.6	0.4
1962	28	40.6	0.4
1963	27	56.6	0.4
1964	27	31.5	0.5
1965	33	24.5	0.5
1966	37	17.5	0.5
1967	35	8.5	0.5
1968	38	12.5	0.5
1969	31	15.5	0.5
1970	20	11.5	0.5
1971	11	3.7	0.3
1972	1	0.5	0.2
1973	0.5	0.007	0.5
1974	0.5	0.001*	1.6
Total	412	338.3	9.0

d. System for Disposal of Nonradioactive Liquid Wastes

(1) Treatment of Industrial Wastes

Heat generated during prototype operations at NRF is removed by circulating secondary system coolant water from the reactor plants to spray ponds or to cooling towers, where the heated water is cooled by evaporation. This process water is treated with proprietary chemicals to control pH, prevent corrosion, and control the growth of algae and bacteria. Water used in the site boilerhouse steam systems is treated similarly. Chemical compositions of water in circulating coolant and in the site boilerhouse are shown in Table II-13.

TABLE II-13

CHEMICAL COMPOSITION OF WATER IN NRF CIRCULATING COOLANT AND BOILERHOUSE WATER

	Circulating Coolant	Boilerhouse
pH	5.8-6.5 (controlled with sulfuric acid)	10.3-11.5 (controlled with trisodium phosphate)
Phosphate	12-17 ppm	150-300 ppm
Sulfite	-	30-125 ppm
Total dissolved solids	1,300 ppm	1,400 ppm

Cooling tower blowdown constitutes the bulk of the water released to a land treatment facility. This water is raw well water treated with sulfuric acid to a pH range of 5.8 to 6.5, phosphate of ∿15 ppm, and proprietary biocides. Another release consists of ion-exchange column regenerants of concentrated sulfuric acid and 50% sodium hydroxide solutions. Raw well water also is processed through water softener units for human use; these softeners are regenerated using sodium chloride, which is released to the facility. Additional nonradioactive water discharges result from blowdown of heat exchangers.

The concentrations of chemicals and solid materials in the cooling and boilerhouse systems are controlled by routine blowdowns which are made by discharging system water to a land treatment facility located adjacent to the NRF perimeter.

Table II-14 lists the characteristics of the water released to the land treatment facility. The utilization of this land treatment facility for such discharges is in compliance with proposed requirements for control of liquid waste material recommended in 1973 by the Idaho Board of Environmental and Community Services[29].

TABLE II-14

TYPICAL ANNUAL NONRADIOACTIVE LIQUID RELEASE CHARACTERISTICS

Land treatment facility:	
1. Quantity - million gallons	100 - 300
2. Water quality	
pH	6.0-8.1
Conductivity (μmhos/cm)	850-5,200
Total dissolved solids (ppm)	700-1,100
Phosphate (ppm)	8-10
3. Released chemicals (lb)	
Chloride ion	244,000
Phosphate ion	28,000
Sodium ion	244,000
Sulfate ion	1,000,000
Proprietary biocides	20,000

(2) Treatment of Sewage Wastes

Sewage from NRF is pumped directly into dual sewage lagoons located immediately northeast of the site, as shown in Figure II-12. The raw sewage is decomposed by atmospheric oxygen or consumed by algae. The lagoons have a combined capacity of 14.6 million gallons. Monthly input to NRF lagoons varies from 1 to 1.5 million gallons, which evaporates naturally. The lagoons are lined with 6 in. of clay soil, which was installed in 2-in. layers and compacted to 95% maximum density. Sediment depth in the ∿600,000 ft^2 of lagoon area increases at a rate of 0.018 in./yr, assuming even distribution of the annual average of 900 ft^3 of nondegradable materials pumped to the ponds. No discharges or overflows from the ponds are anticipated.

e. System for Disposal of Radioactive Solid Waste

Solid radioactive waste materials generated during training, maintenance, and overhaul operations include expended filters and resins from air and water treatment systems, rags, paper, polyethylene, tools, and miscellaneous equipment. All NRF operations solid waste materials that can be compressed are baled in a compactor located at ECF; compaction reduces these material volumes by a factor of about 10. The bales are packaged and transferred to the INEL Radioactive Waste Management

Complex. Materials which cannot be compacted, such as core structural components, are packaged and also transported to the INEL Radioactive Waste Management Complex.

Table II-15 shows the annual volumes and activities of NRF solid waste, compacted and noncompacted, that had been buried since 1961, and indicates the improvements in waste management implemented at NRF in recent years. In addition to installation of the baler-compactor, concerted management attention has been directed to administrative controls to reduce the volume of waste generated. Recent significant reduction in the volume of waste buried is shown in Figure II-14.

TABLE II-15

SUMMARY OF ANNUAL NRF SOLID WASTE BURIAL

Year	Volume ($ft^3 \times 10^3$)	Activity (Ci x 10^3)
1961	27	11
1962	29	12
1963	41	21
1964	36	24
1965	55	501
1966	51	787
1967	49	801
1968	55	193
1969	64	644
1970	68	101
1971	55	55
1972	32	11
1973	16	9
1974	10	6

As discussed above, ECF receives expended naval reactor fuel components which are removed by the Navy from its nuclear powered ships. ERDA assumes custody of the expended fuel at the refueling shipyard, then ships the fuel to INEL. There, the expended fuel first goes to ECF at the NRF where non-fuel-bearing portions of the fuel modules are removed. The spent fuel from the modules then is delivered to ICPP for recovery of the remaining fissile material. The nonfueled portions of the modules are noncorroding materials, such as stainless steel, whose radioactivity is due principally to cobalt-60 produced by neutron

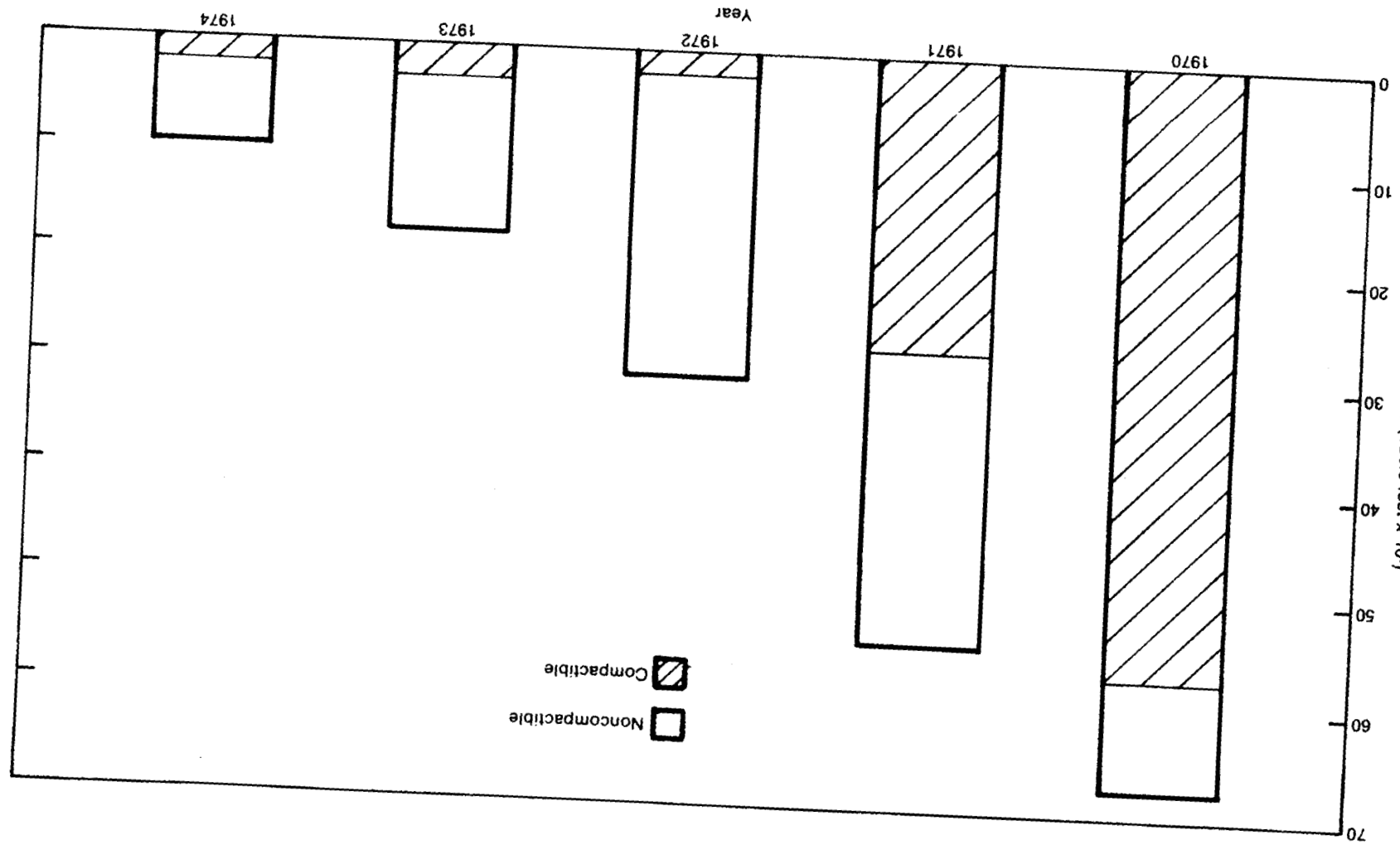

Figure II-14. NRF Solid Radioactive Waste Produced from 1970-1974.

activation during reactor core operation in naval nuclear powered ships. Approximately half of the volume and 95% of the radioactivity in NRF disposed solid waste is produced in these ECF operations.

Stringent controls for packages and transporting of these radioactive solid materials are imposed to prevent any accident which could cause the package to leave the transport vehicle. These controls also include use of INEL security and radiological control escort, a maximum speed of 10 mph, and periodic container and vehicle preventive maintenance. Even if an accident, such as a head-on collision with another vehicle, should result in separation of a container from a transport vehicle, the container integrity would be maintained and no significant environmental radiological effects would result. Furthermore, most of the activity is metallurgically retained within the stainless steel structural components; consequently, any release of radioactive material under any accident situation would be less than for objects contaminated with physically detachable radioactive material.

f. System for Disposal of Nonradioactive Solid Wastes

This kind of waste consists of garbage from the cafeteria, construction debris, barrels of chemicals (liquid and solid), oil, solvents, and wastepaper. This waste is shipped to the INEL sanitary landfill at CFA.